CERAMICS

SEPTEMBER
1954

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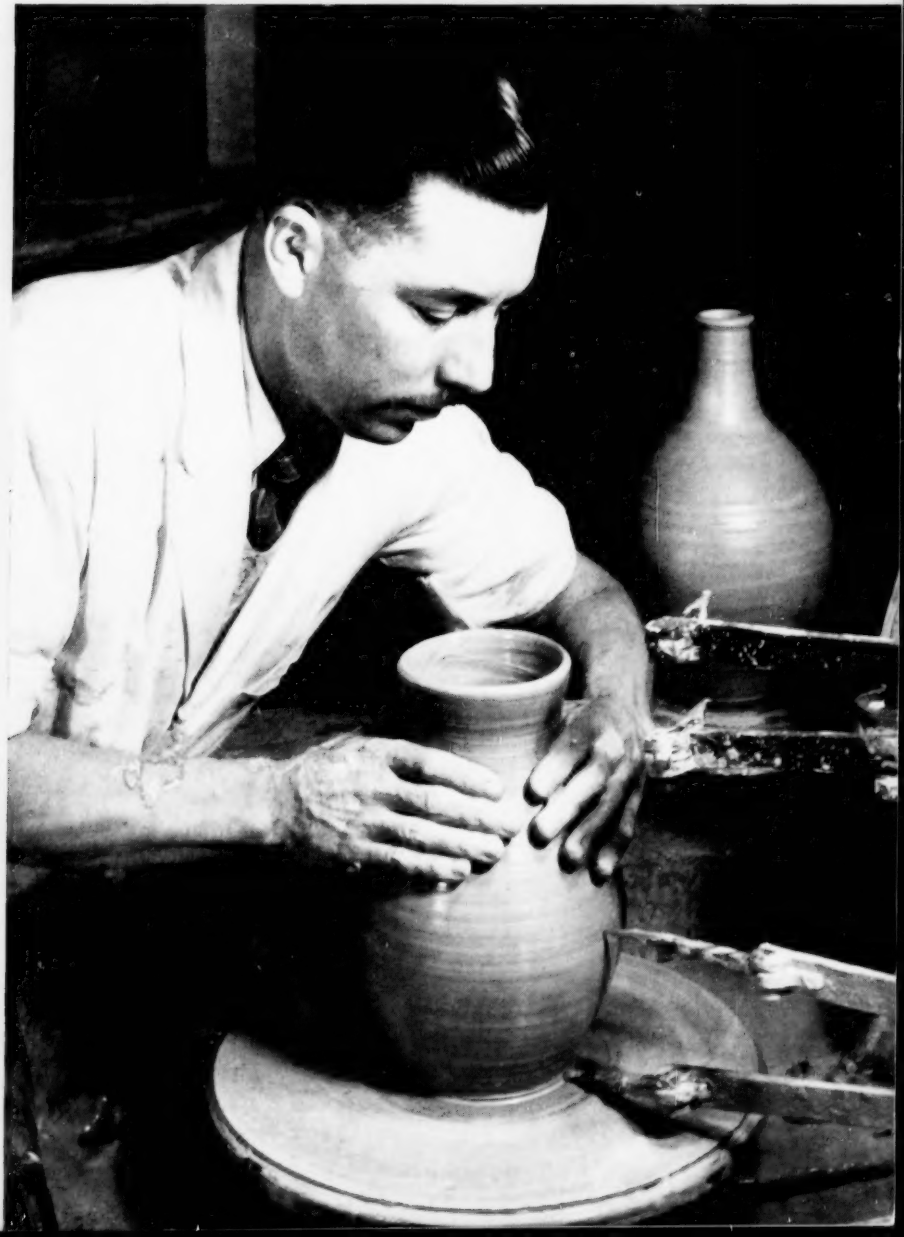

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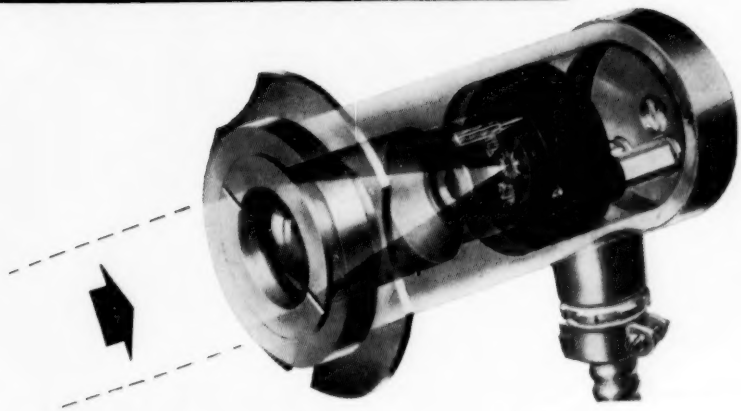

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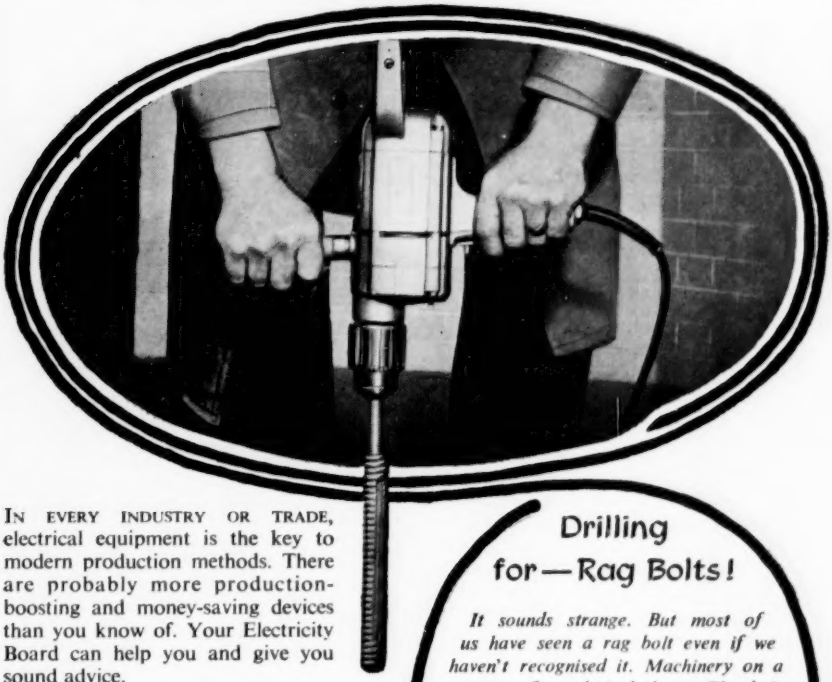

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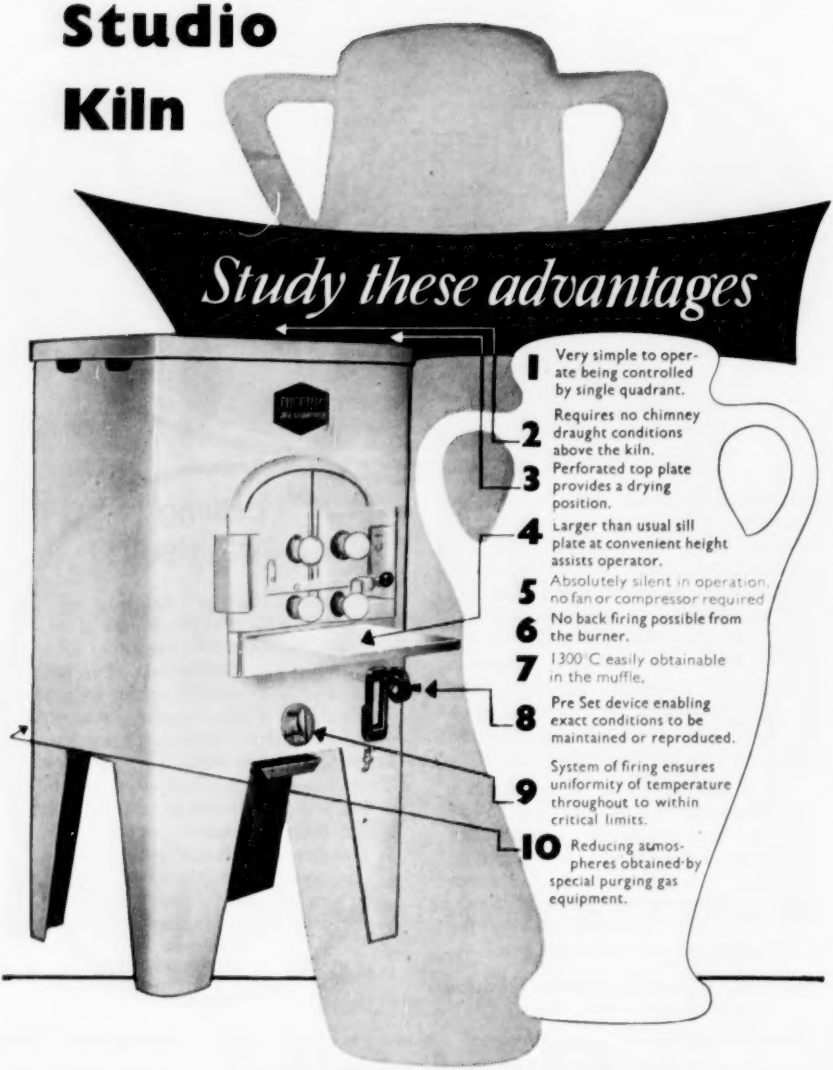
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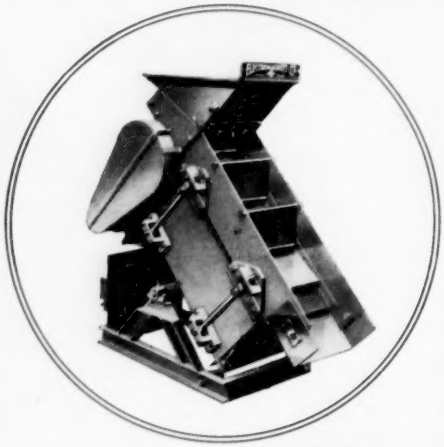

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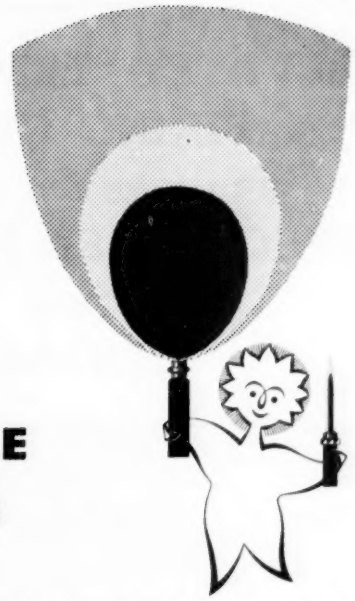

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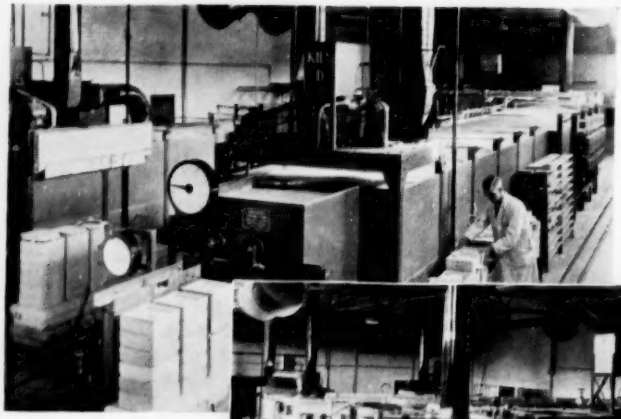

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CERAMICS

A monthly journal covering the pottery, glass, heavy clay, refractory and silicate industries.

SEPTEMBER 1954

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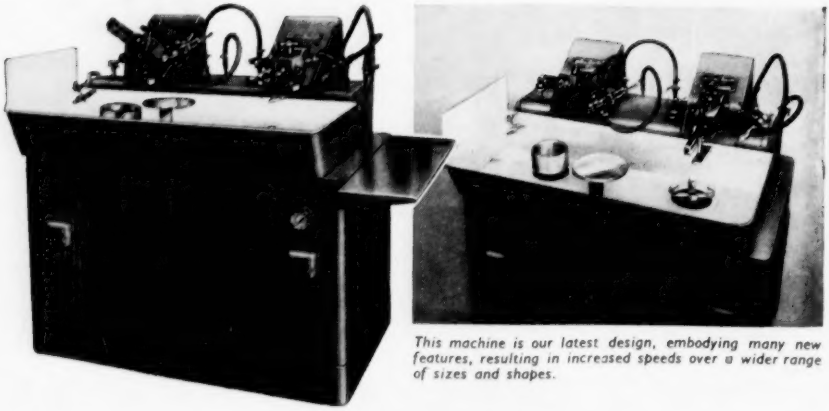

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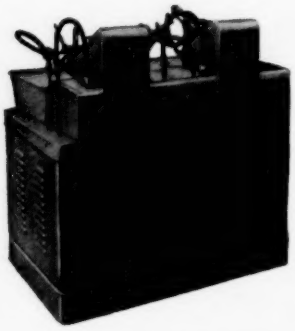

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Ceramics

VOL. VI SEPTEMBER, 1954 NO. 67

Anti-Corrosion

A REPORT published recently by the Organisation for European Economic Co-operation, and available from their offices at 2 Rue André Pascal, Paris 16e, reviews the growing use of non-metallic materials. Glass pipe is used extensively in the manufacturing and processing industries, particularly a new "Double-Tough" made from a specified Corning glass which is claimed to be resistant to corrosion by every acid except hydrofluoric. It will not contaminate sensitive products and is highly resistant to mechanical shock. A new heat strengthening process makes the ends of straight lengths and all fittings except U-bends nearly three times as strong as ordinary glass.

Attention is drawn to the use of fused stabilised zirconia brought about by adding 5 per cent. of lime. This prevents the physical change of pure zirconia at 3,250° F. In the chemical industry gas synthesis processes have been carried out in furnaces lined in this way for long periods at 4,625° F.

Considerable progress has been made with cermets developed for jet engines and gas turbines, standing up to temperatures of 2,600° F. with good creep resistance and high fatigue and rupture strength. It is pointed out that whilst cermets are not unknown in Europe the research on them is more advanced in the United States.

Further reference is made to compounds of the refractory metals such as tungsten carbide, titanium carbide, and alumina, which have excellent wear resistance and strength properties at high temperatures, but lower resistance than metals to thermal and mechanical shock.

One mentions this information simply to show that here in the field of corrosion resistance, which costs the Americans some millions of dollars per year, research on and development of ceramics is proceeding apace.

* * * *

The menace of air pollution and the need to use fuel efficiently is once more brought before our attention by the current meeting of the National Smoke Abatement Society and the recent appeal of the N.I.F.E.S. to firms to send their boiler operatives on courses which are being specially organised throughout the country. Much solid fuel is used in the Potteries and if every company's board could honestly declare that every one of their boilermen was fully qualified and in possession of a certificate of proficiency in stoking, then they would have every reason to be proud. Until that happy situation has been reached there is no occasion for complacency in the board room.

Drying and Dryers for Ceramic Products

(SPECIALLY CONTRIBUTED)

THE subject of drying in the ceramic industries has been the subject of many articles and papers in the past, and will probably continue to be a fruitful source of observation and experiment. The purpose of the present article is to present in a condensed form some aspects of the problem as it affects present-day production. Mr. S. R. Hind, in a paper presented to the Midland Section of the Institute of Fuel at Stoke-on-Trent on 21st February, 1951, gave some production statistics for one section of the industry alone (Table I) namely that connected with china, earthenware, sanitary earthenware, floor and wall tiles and electrical porcelain. (*J. Inst. Fuel*, **24**, 116, 1951).

On the basis that this represented 80 per cent. of the saleable ware, and allowing for a loss of 10 per cent. in production, this represented a factory make of 165,000 tons of clayware per annum.

Assuming an average of 30 per cent. moisture in this the weight of water to be evaporated was 49,500 tons. Drying this with exhaust steam was estimated to require 437,000 tons of exhaust steam at a cost of £245,000.

To this must be added the cost of electricity for fans (estimated to be of the same order) and the capital charges and maintenance on dryers costing between a quarter and half a million pounds. The total annual cost to this section of the industry was, therefore, estimated to be in the region of about half a million pounds.

Coming to clay building materials statistics show the following for 1949:

Building bricks	5,232 millions
Roofing tiles	490,000 tons
Sanitary pipes	443,000 tons

This represents a total of some 22 million tons of clayware, most of which will require some drying. The refractories industry will add a further considerable tonnage. It can be seen, therefore, that the cost of drying ceramic ware is a considerable one. In former times when coal and labour were cheaper than they are today the emphasis on efficiency in drying was not so marked. By and large efficiency in dryers is not as high as we should like, and hence costs are increased.

C. L. Franklin in "Changes in the Theory and Practice of Drying 1900-1950" (*Ceramics — A Symposium*, British Ceramic Soc., Stoke-on-Trent, 1953) quotes figures (Table II) to illustrate the effect of dryer efficiency on cost.

Another aspect of the problem is the demand for greater production, which has resulted in mechanisation of some processes to a scale where existing dryers became a bottleneck on production. This has led to the introduction of dryers to the pottery industry which enable drying to be done at a much faster rate than was hitherto considered possible and this has, in turn, released more floor space as well as decreasing the number of

TABLE I.

	Exports (cwts.)			
	1947	1948	1949	1950
Bone china	67,024	68,835	68,480	92,007
Earthenware	670,620	806,137	814,519	881,002
Sanitary earthenware	529,429	966,806	955,398	1,035,934
Electrical porcelain	62,289	122,062	109,912	114,983
Wall and floor tiles	332,186	547,130	405,498	483,613
Total	1,661,548	2,510,970	2,353,807	2,607,539

TABLE II.

Water evaporated lb./hr.	*Evap. efficiency (per cent.)*	*Steam used.*		*Annual Cost, £ at 6d./100 lb. steam*
		lb./hr.	*lb./year*	
60	50	107	268,000	67
60	30	179	446,000	112
60	10	534	1,332,000	333

plaster moulds required by a maker at any one time. An increasing use of waste heat from kilns has also followed from the continually rising cost of fuel.

Principles of Drying

The principles of drying need only be summarised very briefly here. In drying clayware the water is evaporated into the air. The rate at which this can proceed depends on the temperature. Air can become saturated with moisture and to get maximum removal the temperature may be increased, or the moisture laden air removed by circulation. The practical limit to raising the temperature is that if the moisture is removed from the surface of the clay more quickly than it can diffuse from the inside to replace it differential shrinkage will occur on the outside, and cracking will follow when the strain on the clay due to this exceeds its mechanical strength. Articles such as large insulators and large conduits present a problem in drying because of this. In such cases it is necessary to raise the temperature of the ware by heating it without allowing the surface to dry. This is done by "humidity" drying in which in the first stage the ware is heated in a saturated atmosphere. Subsequently, the water can be evaporated by admitting drier air. With such articles drying is necessarily slow. In extreme cases where the temperature is raised too abruptly, vaporisation of the water to steam may occur inside the ware, which may shatter explosively.

For speedy and safe drying, therefore, the following devices can be considered:

(a) The ware may be heated from the inside outwards by dielectric (high frequency) drying.
(b) Combinations of heating and forced convection.

Whenever possible waste heat will be used in these applications.

Dielectric (High Frequency) drying

Dielectric heating involves subjecting the article to the action of high frequency waves, when heat is generated on the article, and the centre becomes hotter than the outside. This is a very desirable feature with clayware, since it ensures that water tends to flow to the outside at a sufficient rate to balance evaporation losses, with reduction in losses from cracking. Experiments to apply this to drying pottery have been described by Mr. Spencer Copeland (*Trans. Brit. Cer. Soc.*, **51,** 573, 1951-2). The results

TABLE III.

Method	*Power.*	*Time (mins.) to remove first 50 gm. moisture from 10 in. plate without damage.*
Radio frequency	2,000 W.	4½
Radio frequency	2,000 W. for 3¾ min. air drying for 2¾ min.	6½
Infra-red gas chamber	—	11½
Infra-red dull panel	200 W. 250 V.	38½
Standard steam dryer	—	60-120

(Table III) show that very rapid drying can be achieved.

This would be useful for getting quick mould release, when drying could proceed on more orthodox and cheaper lines. The great disadvantage of high frequency drying is the high cost, which was estimated in the experiments between 1s. 1d. and 1s. 9d. per 10,000 B.T.U. or between 11s. and 17s. 6d. per therm. Until the efficiency of the process can be improved there seems to be little prospect of the application of this method of heating in the ceramic industry, except for very special applications.

Infra-Red Drying

The use of this for drying pottery has been described on many occasions. H .W. Webb and S. W. Ratcliffe (*ibid*, **44,** 119, 1944-5) have examined the question in some detail for pottery and have concluded that drying in this case could be done more cheaply with an efficient convection dryer. Care must be taken with radiant heat dryers to avoid overheating the plaster moulds. Where the drying is more straightforward, as in drying biscuit sprayed or dipped in glaze, or of metal heated with enamel, then infra-red heating finds an application.

Convection Dryers

The use of streams of hot air for drying is probably the most popular way. In this method the drying occurs through the medium of a thin film of air which is in immediate contact with the surface of the ware. Heat is transmitted to this mainly by conduction, and water vapour escapes to it by diffusion. Without some means of renewing this air film a static state soon arises and drying falls off. Circulation of the air is a way of renewing the air film and by using velocities up to 1,000 ft. per min. the rate of drying can be increased about 200 per cent. (A. E. Stacey, *J. Amer. Cer. Soc.*, **8,** 457, 1925). Striking examples of this can be seen in drying sheds. In one factory where fireclay articles were being dried on a hot floor, the installation of fans suspended from the roof gave a wide circle under each where the ware was obviously dry, while outside that area it remained a darker colour due to being much wetter.

The hot air for drying may be derived from waste heat from a kiln. This is popular particularly in the heavy clay industry, and the use of air drawn through cooling fired bricks, and then passed to chambers containing freshly set material is familiar to all users of continuous kilns of the Hofmann and later types.

Tunnel kilns may have a dryer built alongside to enable waste hot air to be used on the freshly set cars of ware before pushing them on into the kiln for the firing operations. Intermittent kilns can also be used to provide hot dry air by fitting them with ducting and pulling in clean air from outside through the hot fired kiln by means of a fan. The clean hot air is then used to dry ware on drying floors or in dryers. In this way it has been possible to recover 40 per cent. of the heat available in the kiln and setting. This aspect of the problem of drying was discussed in an article entitled "Waste Heat Utilisation" in the December, 1953 issue of CERAMICS. (CERAMICS, **5,** 444, 1953.) In all these methods, however, the nature of the setting and the circulation of air has been such that it was impossible to ensure that all the articles dried at a uniform rate. Odd pockets occurred in which the air remained static, and hence drying was slow.

Pottery Dryers

With pottery, we are dealing with much smaller and thinner articles, and the prospects of accelerating drying of these are better. Moreover increases in the rate of production of these have rendered further drying imperative. As S. R. Hind (*loc. cit.*) points out, if articles are being made at the rate of six a minute and the drying time is 2½ hours, then the dryer attached to the machine must hold a minimum of 900 articles and the only way to reduce its size is to reduce either the rate of making or to increase the rate of drying. It is to the latter alternative that one looks for improvement.

The limitation in degree of heating is also influenced by the fact that the ware is formed on plaster moulds, which are not to be heated much above 120° F. for long periods, though for shorter periods they are now sometimes heated to 160° to 170° F. The moulds are supported on horizon-

tal arms on vertical spindles which can be rotated in the familiar "dobbin" type or on horizontal trays in the mangle type. In both cases hot air is forced around the dryer by fans, the heating being done by steam pipes fed by waste or live steam, or in some cases electric unit heaters can be used. Considerable ingenuity has been exercised in these types to avoid occupying too much space, and also to fit in with production lines. A summary of the types of dryer used in the pottery and similar branches of the ceramic industry is given in S. R. Hinds paper (*loc. cit.*). Other details are given for the wall tile industry by L. Bullin (*J. Inst. Fuel*, **27**, 115, 1954). Efficiencies of these dryers showed considerable variations, and tests have given results ranging from 11 to 48 per cent. calculated on the total heat input. The higher results were obtained on the new types of dryer operating at faster speeds.

Jet Dryers

It had already been known that rate of evaporation could be increased by increasing air velocity and by making the air impinge perpendicularly to the surface. In 1943, R. B. Bloore patented a jet drying apparatus for cups. (R. B. Bloore and Synnertons Ltd., *Brit. Pat.* 565,989, 12th Feb., 1943), and two years later a dobbin was produced in which the ware was dried by a single jet, the moulds being continuously under the jet. From this it was a short step to the use of multiple jets, and prototypes for use on smaller kinds of flat ware were produced in 1947 and proved successful. Later models dealt with larger sized flat ware.

G. W. Bird and A. J. Dale (*Trans. Brit. Cer. Soc.*, **51**, 559, 1951-2) have described their experiments carried out in co-operation with the Victoria Heating and Ventilating Co. Ltd., Stoke-on-Trent, on the evolution of jet dryers. The general construction follows that previously in use (Fig. 1) but the shelves supporting the moulds and ware are hollow, and perforated on the under side so that jets of hot air can be directed on the clay ware. Arrangements are made to cut off the air supply in the sections open to the shop for loading and unloading. For drying flat ware it is important to maintain at all points a uniform rate otherwise "humpers" and "whirlers" are formed. As the flat ware rests bottom upwards on the mould the plate edges are farthest away from the jets, and the centre nearest. Consequently, if no allowance is made, the centre of the back tends to dry out first, and a whirler is produced. To overcome this difficulty the size and positioning of the jet was altered as in Fig. 2. Nowadays, the three outer circles of jets are $\frac{1}{4}$ in. dia. the three inner ones $\frac{3}{8}$ in.

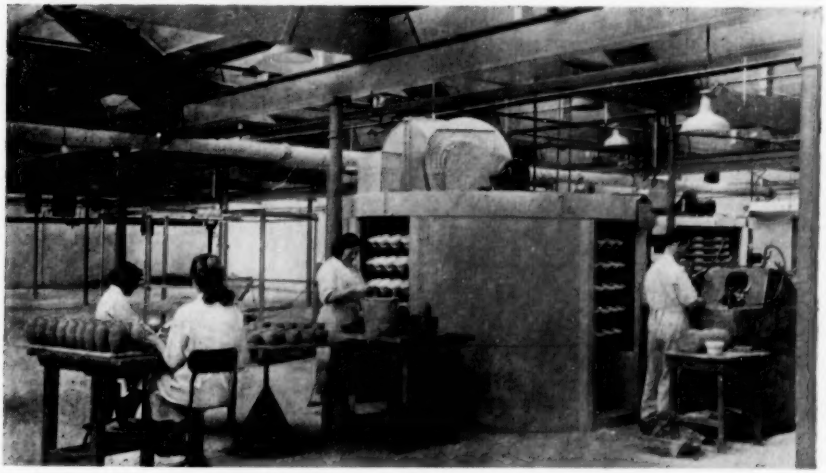


Fig. 1. Rotary multi-jet-dryer for cups

(Photograph by courtesy of Victoria Heating and Ventilating Co. Ltd.)

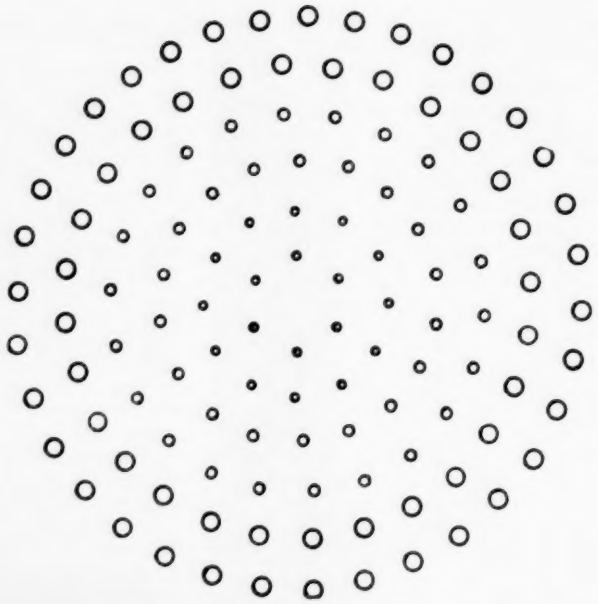


Fig. 2. (Right). Jet plate for large flatware with jets arranged in concentric circles

(Photograph by courtesy of Victoria Heating and Ventilating Co. Ltd.)

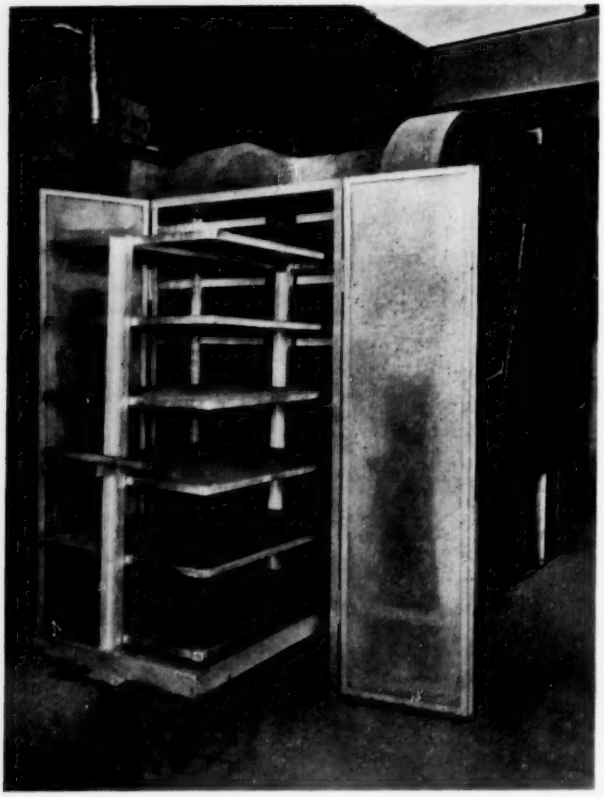


Fig. 3. (Left). Combination truck and stove jet dryer for dishes

dia. and a 2 in. circle in the centre has no jets. This allows a greater volume of air to infringe in the parts farthest away from the jets, and gives uniform rate of drying. This preservation of shape is an important part of this method of drying.

For cups a dobbin type stove was also used with a single jet above each cup. This was $\frac{1}{2}$ in. dia. and the top of the cup mould was approximately 1 in. below the jet. The air velocity at the jets was 420 ft. per min., and the air delivered was 2,400 cu. ft. per min., and the temperature 105° F. The saucer dryer was equipped with $\frac{3}{16}$ in. dia. holes spaced at 2 in. centres, and the highest part of the saucers was 2 in. below the jets. The air consumption and its velocity and temperature were very similar to that of the cup dryer.

The flat dryer mentioned above worked at 120° F. and the air velocity was 450 ft. per min. at the jet—the actual volume delivered being 3,500 cu. ft. per min.

For dishes and jiggered holloware the same principle was used, but special trucks were designed (Fig. 3). These were stood near the maker and when full were wheeled into the dryer where the air supply was turned on. Using a temperature of 105° F. and an air velocity at the jets of 400 ft. per min., it was found possible with this type of ware to reduce considerably the number of dryers required, with consequent saving in floor space of over 50 per cent. As an example of the economies to be realised in the use of the jet drying system Bird and Dale produced the data given in Table IV.

In the table the total B.T.U.'s was calculated from steam consumption and electric power converted to B.T.U. assuming a power factor of 0·6.

As examples of the cost savings the same authors produced Table V.

These costs savings are substantial, and explain the increasing popularity of jet drying in those cases where it

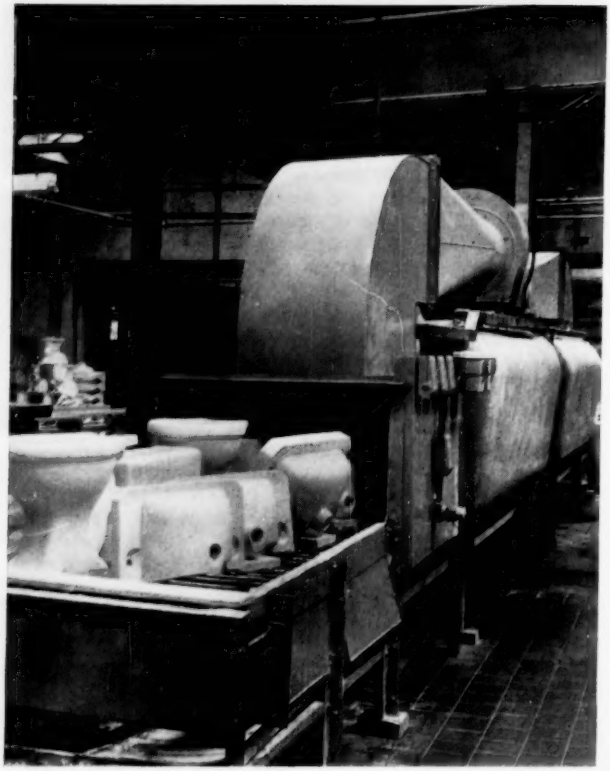
TABLE IV.

Type of Ware	*Stove.*	*Heating.*	*Drying time. hr.*	*Total B.T.U./ lb. water evap.*
Cups	Mangle	Steam-hot air	$\frac{1}{2}$	5,991
	Dobbin	Steam-hot air-jet	$\frac{1}{2}$	2,307
Saucers	Dobbin	Steam-hot air	$1\frac{1}{4}$	2,064
	Dobbin	Steam-jet	$\frac{3}{4}$	955
	Mangle	Steam-hot air	$1\frac{1}{2}$	2,366
Flat	Dobbin	Steam-hot air-jet	$\frac{3}{4}$	1,268
	Dobbin	Steam-hot air	2	2,068
Dishes	Truck	Steam-hot air-jet	$1\frac{3}{4}$	1,833
Holloware	Truck	Steam pipes	6	6,700
	Truck	Steam-hot air-jet	$1\frac{1}{2}$	4,246

TABLE V.

Cost (in pence) to evaporate 100 lb. of water.

Type of Ware	*Method*	*Steam*	*Power*	*Total*
Cups	Steam heated mangle-hot air	30·24	41·0	71·24
	Dobbin steam heated-jet	11·20	26·3	37·5
8 in. flat	Dobbin steam heated-jet	6·72	7·64	14·36
	Dobbin steam heated hot-air	11·03	8·20	19·23



can be applied. It has recently been used for drying sanitary ware and glaze dipped ware. (Fig. 4). (W. Hancock, CERAMICS, April, 1954).

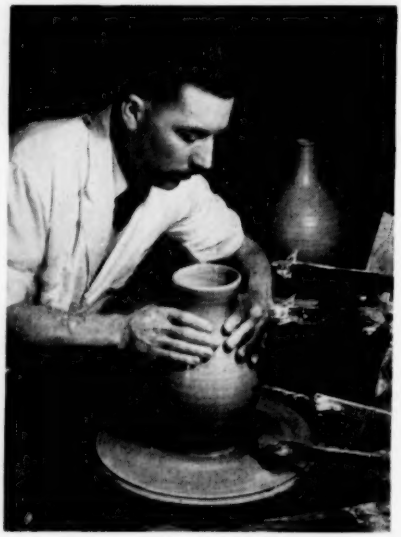
Fig. 4. A steam-heated jet dryer for sanitary ware

OUR COVER

NEXT month, continuing our series of feature articles on small traditional and contemporary style potteries, we shall be publishing an article on the growth and achievements of the Poole pottery of Carter, Stabler and Adams Ltd.

Poole, unlike most commercial potteries still employs three skilled throwers who make all the firm's vases and bowls. Our cover this month shows the firm's senior thrower at work. The hand-painted ware has established a tradition especially in the west country, and the name of Poole has been a household word now for over a quarter of a century.

The pottery, which is built around a triangular garden of flowering shrubs, overlooks the waters of Poole Harbour with Brownsea Island and the Purbeck Hills in the background.



Injection Moulding of Ceramics

THE injection moulding of ceramics so that components can be turned out on production lines similar to existing methods in the plastics industry, would constitute an enormous advance in the ceramics industry. Extensive investigations have recently been carried out in America on steatites, zircons, and zircon-steatites and considerable success obtained.

In the early stages of the experiments a great number of difficulties had to be overcome. A converted 150 ton extrusion press with a hydraulic cylinder ram of 28 tons maximum had to be scrapped before a suitable press was acquired. An overwhelming majority of materials gave very poor results and various moulds had to be designed and redesigned.

Various problems, too, were encountered in press operation, material preparation and firing of specimens. The type of die used was a so-called "1-4" die; the numbers "1-4" representing the approximate sizes of the cavities which were a 1 in. dia. disc and a rod 4 in. long. The most successful part of the experiments consisted in keeping the mould or die design constant and concentrating on materials for injection. This involved the use of ethyl cellulose flake with several conventional plasticisers for this resin.

The table given overleaf (Table I) represents body compositions of the resin type materials which were processed and injected during the latter successful part of the experiments.

The term plasticiser is used in the same sense as that used in the plastics field. It is a modifier or softening agent for the particular resin being used—in this case ethyl cellulose. Many of the plasticisers mentioned in Table I are trade names for specific chemical compounds, but their compositions are given here. Hercolyn is considered to be hydrogenated methyl abietate (methyl dihydroabietate). It is a chemically stable liquid resin possessing the following outstanding characteristics: low vapour pressure, thermal stability, alkali resistance, and a wide range of compatibilities with diverse materials. In addition, it has the trifunctional ability to act as a plasticiser, solvent, and resin simultaneously. It was recommended for use with ethyl cellulose flake in an 80:20 ratio (ethyl cellulose: plasticiser). The flake represents a low viscosity (14 cps. at 5 per cent. concentration by weight and 25° C.) ethyl cellulose containing 47·5 per cent. to 49 per cent. ethoxyl.

Plasticiser KP 120 is methoxy ethyl acetyl ricinoleate or methyl "Cellosolve" acetyl ricinoleate. It has a very low vapour pressure—less than 0·01 mm. Hg. at 150° C. Kronitex AA is tricrosyl phosphate which also has a vapour pressure of less than 0·01 mm. Hg. at 150° C. It is recommended for use with ethyl cellulose.

"Flexol" plasticiser 3 GO (shortened to 3 GO in the table) is the chemical compound, triethylene glycol di-2-ethylhexeate, or triglycol dioctate. It is claimed that this plasticiser is particularly useful in resins and synthetic rubbers where it is desired to provide a uniform flexibility over a wide range of temperatures. Dibutyl phthalate is slightly more volatile than the other plasticisers having a vapour pressure of 1·1 mm. Hg. at 150° C. It was chosen for use with ethyl cellulose, because it is compatible with the resin and has been used extensively in the plastics field.

Plasticisers like the above can be obtained with these chemical definitions.

Butyl stearate has the outstanding property of being a lubricant as well as a plasticiser for ethyl cellulose. It is compatible with ethyl cellulose but is not a solvent for it.

The mixing procedure may be somewhat involved at first glance but the method lends itself to the production

of a large number of compositions in a short time.

Compositions 1 to 28 were processed using the ceramic base material given under base A, while 29 and 30 were processed from ceramic base B. These two ceramic bases have the following compositions:

BASE A.

	per cent.
Talc	70
Barium zirconium silicate	20
Plastic kaolin	10

BASE B.

	per cent.
Talc	85
Ball clay	12
Bentonite	3

Base A is a steatite containing good thermal qualities. Specimens produced by extrusion methods successfully passed specifications set as a target at the start of the experiments. Base B is a production grade steatite body. Loose granules of pressing material were calcined at the maturing temperature for the body, 2,300° F. The vitrified granules were crushed by ball milling, wet ball milling, and micropulverising. The resultant powder was substantially minus 325 mesh and was combined with ethyl cellulose flake and shellac by blending in a spiral ribbon mixer and micropulverised. Subsequent additions of plasticiser were made at 300° F. The most important reason for using the foregoing method was to study the effect of calcination of a steatite composition on the injection process.

Body A was prepared as follows: weigh, blend in mixer, micropulverise. The secondary base materials 1, 2 and 3 were prepared in the same fashion except that the required amounts of resins were added. The amounts of plasticisers, as shown in Table I, were

TABLE I.

Body Compositions.

No.	*Base or Resin, per cent.*	*Plasticiser† per cent.*
1	10 E.C.,* 2 shellac	
2	15 E.C., 2 shellac	
3	15 E.C., 0 shellac	
4	As No. 2	3 Hercolyn
5	No. 1	3 Hercolyn
6	No. 2	5 Hercolyn
7	No. 1	10 Hercolyn
8	No. 2	5 KP 120
9	No. 2	5 Kronitex AA
10	No. 1	10 3 GO
11	No. 1	10 dibutyl phthalate
12	No. 3	3 dibutyl stearite
13	No. 3	5 dibutyl stearite
14	No. 3	5 dibutyl phthalate
15	No. 3	10 dibutyl phthalate
16	No. 3	10 Kronitex AA
17	No. 2	8 Hercolyn
18	No. 2	8 Kronitex AA
19	No. 2	8 KP 120
20	No. 2	8 3 GO
21	No. 2	8 dibutyl stearite
22	No. 1	10 dibutyl stearite
23	No. 1	13 Hercolyn
24	No. 1	10 KP 120
25	No. 1	10 Kronitex AA
26	20 E.C., 2 shellac	25 butyl stearate
27	16 E.C., 2 shellac	4 butyl stearate
28	16 E.C., 2 shellac	6 butyl stearate
29	15 E.C., 2 shellac	2 butyl stearate
30	10 E.C., 2 shellac	3 butyl stearate

**The abbreviation, E.C., under base or resin, represents ethyl cellulose flake.*
†The term plasticiser is explained in the text.

added at the mixer and plastification was carried out at 290° to 340° F.

In the injection process the granular materials were fed to the injection heating cylinder manually and then the press took over automatically. While the machine was operating automatically it was possible to change such factors as mould temperature, injection dwell, curing time, and heating cylinder temperature. Other required settings such as stripper bar adjustment, limit switch for reduction to stripping speed, cam operated switch for reduction of clamping speed, nozzle separation or sprue break, and limit switch for reduction of "approach" to "pressing" speed of injection, were kept constant.

The basic idea of baking and firing was to remove the relatively large amounts of resin and plasticiser very slowly and carefully. The schedule employed successive increases and soaking or holding periods. Increases of about 30° F. were made in an hour while the soaking time varied from two hours to 16 hours.

The secondary base materials, 1, 2 and 3 listed in Table I were further used in 2,000 gm. portions with compositions 4-25 with the particular plasticiser as listed. The primary ceramic base material for all of these bodies, plus 26, 27 and 28 was Base A.

The outstanding feature of the entire series was the use of ethyl cellulose flake. That used in the experiments was a white powder with the following particle size distribution: 86·6 per cent. through 40 mesh, 31·6 per cent. through 60 mesh, 2 per cent. through 100 mesh, and 0 per cent. through 200 mesh. It was somewhat brittle and was pulverised readily with care. The flake was reduced to 96·9 per cent. through 40 mesh, 70·6 per cent. through 60 mesh, 27·0 per cent. through 100 mesh, 8·7 per cent. through 200 mesh, and 3·1 per cent. through 270 mesh with only one pass through the micropulveriser. A much better dispersion of resin was thus possible. A good homogenous mix was obtained at the mixer and no particles of ethyl cellulose were visible.

Composition Characteristics

Here are the results of each composition:

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No. 4.—330° F. was the best injection temperature. Mould temperature was set at 126° F. Injection was accomplished at the maximum pressure available, 27,000 lb./sq. in., and with a nozzle of 0·375 in. The sprue was 0·406 in. at the nozzle and 0·875 in. at the cavity end. Runners to both cavities were circular and about $\frac{7}{16}$ in. dia. The gate at the rod cavity was also circular but 0·375 in. dia. The gate at the disc cavity fanned out from $\frac{3}{8}$ in. to about $\frac{3}{4}$ in. and was $\frac{1}{8}$ in. thick. The ejector bar was set at $3\frac{5}{16}$ in. All of the preceding factors remained constant throughout the injection of the series. Nozzle adjustment was made at 350° F.

"Hot" mixing of No. 4 was accomplished at 320° F. No granulation was obtained with heat alone but the mix became soft and gummy upon the addition of plasticiser. Very tough and nearly spherical granules resulted upon cooling to room temperature. The granules were about 1/16 in. dia. and constituted 50 per cent. of the mix. The remainder was "fines" (48 mesh). Fairly good flow to the cylinder was experienced. The set was brittle and very strong, but generally poor structures were obtained. Serious sticking in runners and cavities occurred during the last portion of the run. Sprue, runners and cavities showed a skin and core effect while some of the shots were incomplete. These examples of lack of flow to the cavities showed inadequate plasticity. The "sprue puller" was usually broken off when the mould halves separated. This "puller" was dense and tough and had to be chiselled from the sprue injector pin insert. Experimentation was cut short and the "plug" was removed. The cold plug revealed three distinct layers: a thin brown skin 1/16 in. thick was very smooth and glossy exhibiting mica marks; the next layer was $\frac{1}{4}$ in. thick while the remainder was a core $1\frac{1}{2}$ in. thick in dia. The entire plug, however, seemed plasticised and no separate particles of ethyl cellulose were visible. The plug, taken as a unit, had set to a rock-like mass.

No. 5.—The series actually began with this mix because it contained the least amount of combined resin and plasticiser. No flow from the nozzle over the temperature range 290° to 375° F. resulted and the mix was therefore discarded.

No. 6.—This mix behaved practically the same as No. 4 except that it was slightly more plastic. Flow from the nozzle was very rapid at 27,000 lb./sq. in. The "extruded" rod blistered and split as it emerged. Automatic injection settings of 10-30-3 (10 sec. injection dwell, 30 sec. curing, 3 sec. die opening) gave the best specimens. Structures were fairly good except for the sticking experienced with No. 4. Best feature was the rock-like set. Excessive sticking classed it as a failure but an oily substance could be added to the mix to serve as a lubricant.

No. 7.—Injection at 300° F. and settings of 10-90-3 and 10-180-3 gave excessive stickings and a soft "set." Discarded.

No. 8.—Injection at 290° F. and settings of 10-180-3 gave fair structures and a soft set. Specimens were difficult to knock out without distortion. Outstanding failures were a slight sticking and some weld lines.

No. 9.—Best results were obtained at a cylinder temperature of 290° F. and setting of 10-60-3 and mould temperature of 68° F. Structure appeared to be good and a good set was obtained, but slight sticking occurred in the rod cavity. This was overcome with the use of a mould lubricant and smooth surfaces were produced. However, structures were not quite as good as those obtained without lubricant and faint flow or weld lines were visible.

No. 10.—Failed to set. Discarded.

No. 11.—Specimens were still soft even after maximum curing time of 180 sec. Structures were only fair and showed weld lines.

No. 12.—Cavities incompletely filled. Best results obtained at 310° F., mould 122° F. and settings of 10-90-3. Disc surfaces were very smooth but the rod stuck slightly. The end of the run was featured by a white haze in the cavities.

No. 13.—Outstanding feature of this mix was a glossy surface on injection at 300° F., mould 84° F. and settings at 10-30-3. Slight sticking and weld lines evident. A good set but lack of shellac was possible cause of sticking.

No. 14.—Pungent odour denoted a comparatively volatile material. Dibu-

tyl phthalate is possibly the most volatile plasticiser used in this series. Injection at 300° F., mould 80° F. and setting 10-60-3 was characterised by slight to serious sticking. Set was good, but sprues did not pull.

No. 15.—Injection at 300° F., mould 68° F. and setting 10-60-3 was characterised by slight sticking, no sprue pull without lubrication and insufficient set. Blisters developed on several specimens.

No. 16.—Distortion of specimens on removal.

No. 17.—Structures excellent except for 1 in. from the back end of the top surface of the rod. The disc also exhibited faint weld lines. Good set obtained and all surfaces very smooth. Many sprues pulled but only after application of mould lubricant. Injection was at 290° F., mould 102° F., setting 10-60-3. No sticking occurred until mould temperature was increased to 119° F. to reduce flow lines. Only slight improvement noted. Curing time was increased to 90 sec. in order to maintain the same set. Sticking persisted.

No. 18.—Injection was at 300° F. to a cavity at 110° F. Set was too soft and slight sticking occurred. Lower mould temperatures produced better set but gave more prominent weld lines. Several discs blistered and the end of the run was characterised by white haze in rod cavity.

No. 19.—Injection at 290° F. into mould at 115° F. gave very good structures. A cure at 120 sec. gave a soft set, and at 180 sec. only slightly stronger. Some of the discs were the best moulded up to this point in spite of slight sticking. Generally results were excellent.

No. 20.—Rejected due to soft set at 180 sec. and severe sticking.

No. 21.—Excellent results obtained at 290° F. and 300° F. into mould at 84° F. Rods were the best moulded so far while discs were also very good. Surfaces were smooth; no sticking or blistering was encountered. Set was fair but perhaps a little too soft. Only faint flow lines were seen while the internal structure appeared to be excellent.

No. 22.—Poor set at 300° F. Material too weak in spite of 180 sec. cure.

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No. 23.—Good structure on injection at 116° F. and cure of 180 sec. All surfaces smooth but set slightly soft. Better set was obtained by reducing mould temperatures to 84° F. but faint weld lines visib'e. Lubrication was essential.

No. 24.—Injection very poor with severe sticking and soft set.

No. 25.—Failure under various conditions. Blistering and sticking developing.

No. 26.—Injection at 300° F. and 310° F. gave apparently good structures. Faint weld lines were visible but internal structure seemed excellent. Set was good at all curing times, but 30 sec. was optimum for mould temperature of 118° F. Hard and brittle specimens with smooth, glossy surface yet slight sticking. Mould temperature of 88° F. eliminated sticking but introduced prominent weld lines. Appears to require additional internal lubrication to reduce sticking. Possible changes are reduced ethyl cellulose, increased butyl stearate, and increased shellac.

No. 27.—Injection at 290° F. and 300° F. into 120° F. mould gave good structures but some sticking. Set was good for 5-30-3 sec. but lubrication necessary. Severe sticking at end of run.

No. 28.—Injection under the following conditions gave excellent results: front of heating cylinder 290° F., rear 310° F., mould temperature 72° F. and automatic settings of 10-60-3. Features were 1, no sticking; 2, good set; 3, excellent sprue pull; 4, faint weld lines. Most important was excellent sprue pulling quality. Sixteen of a total of eighteen sprues were pulled without benefit of external lubrication. Such can be classed as truly automatic injection. The injection "tree" consisting of sprue, runners, gates, and specimens was also easily removed from the knock-out punches permitting rapid and continuous moulding. All surfaces were very smooth and internal structures apparently dense and uniform. Only defect was faint flow lines. Higher heating cylinder temperature and higher mould temperature would probably improve this, although sticking might result.

No. 29.—No flow at all.

No. 30.—Material "froze" in the nozzle and injection incomplete.

Firing

The best specimens of the following materials were chosen: Nos. 4, 6, 8, 9, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 23, 25.

The baking schedule was as follows:

Temp. °F.	*Rise (hrs.)*	*Hold (hrs.)*
70 to 113	2	16
113 to 140	2	2
140 to 217	4	2
217 to 237	2	16
237 to 284	1	16
284 to 316	5	2
316 to 341	4	16
341 to 360	8	16
360 to 392	2	2
392 to 450	2	2
450 to 600	2	2
600 to 900	2	2
900 to 1100	2	12
1100 to 1500	2	12

Further firing to maturity (2,330° F.) was accomplished in a production gas-fired tunnel kiln. In spite of the apparent care in removing resins and plasticisers, most of the specimens exhibited one or more of the following defects: blisters, cracks, fish-scales, laminations, weld lines, warpage and bubbles. The rods in particular gave poor results. Nos. 6, 18, 19, 21, were the best. Discs were generally much better, discs for Nos. 19 and 21 were apparently good. Silver electrodes were applied and fired on these specimens. Power factor and dielectric constant were determined at 1 Mc and 25° C. The results are given in Table II.

TABLE II.

Material	*Average-Dry*			*Average-Wet*		
	P.F.	*K.*	*L.F.*	*P.F.*	*K.*	*L.F.*
No. 19	0·000721	6·80	0·00490	0·00142	6·80	0·00963
No. 21	0·000730	6·93	0·00505	0·00144	6·93	0·00993

These values were most promising although not definitely conclusive. The "dry" values are well within the high standard set but the "wet" values are of a lower grade. Increase in power factor on the "wet" test was unexpected since the specimen structure is not quite as good as it should be. Faint flow lines were visible on nearly all fired specimens including the best ones reported in the above table. Porosity was determined by an ink immersion test and all specimens found to be vitreous in ink.

Baking accentuates any defects which may be present in the specimen as moulded. The "as moulded" state is often deceptive. Weld or flow lines may not be visible in moulded specimens but will appear as cracks in bisque fired specimens. Such defects as blisters and fish-scales can, of course, be avoided through careful elimination of resins and plasticisers.

Glazing

The following glaze compositions are given for use on any of the steatite bodies, and should be satisfactory for any of the compositions listed in Table I. Glaze 1A is a "high fire" glaze maturing at 2,300° F. on a 24 hr. cycle with a soak of approximately 2 hr. at peak temperature. It is preferably applied to a "green" body and fired to maturity simultaneously with the body. Glaze 2A on the other hand, is applied to bisque fired ware and matured at 1,775° F. on a 12 hr. cycle with an approximate soak of 1 hr. at peak temperature. Compositions:

1A

	per cent.
Feldspar	70·4
Talc	4·7
Clay	10·7
Flint	14·2
Gum Chatti	0·5

2A

	per cent.
Lead Bisilicate ...	90·55
Clay	9·45
Gum Chatti	0·5

Conclusions

The experiments recorded here could be taken many stages further until the absolute ideal material and mix was discovered. The measure of success attained on purely laboratory scale indicates the likelihood of finding a perfectly satisfactory method. The conclusions which can be drawn at this stage, other than those already indicated, are as follows:

1. Ethyl cellulose is definitely the best thermoplastic resin.

2. Butyl stearate is the most generally satisfactory plasticiser, for ethyl cellulose.

3. In earlier experiments (not discussed in this article) the best connector specimens were obtained with two materials: steatite base of 85 per cent. talc, 15 per cent. clay with a plasticiser of 20 per cent. ethyl cellulose, 2 per cent. shellac and 2 per cent. butyl stearate; and the same steatite base with a plasticiser of 30 per cent. cetyl alcohol.

4. The best fired discs were obtained from materials Nos. 19 and 21 while the best material for truly automatic injection is No. 28.

5. A careful, slow baking schedule is required for successful elimination of auxiliary "binders." However, complete success cannot be achieved if invisible laminations, weld lines, and internal strains are present.

6. Generous passages are required for minimum weld lines. Nozzle, sprue, runners, and gates should be as large as practical in order to present adequate pressure transmission from the source of pressure to the cavities. Another important factor is mould temperature. This variable should be sufficiently high to prevent "freezing" yet low enough to permit an adequate "set" in a reasonable curing time. Proper balance among mould temperature, curing time, and injection dwell are required to give both minimum weld lines and adequate set.

7. Such factors as injection pressure, injection-cylinder temperature, and injection speed, vary with the material formulation and dependant plasticity. Material No. 28 performed well under the following conditions: 27,000 lb./sq. in. injection pressure, 290° F. front cylinder, 310° F. rear cylinder, and a speed of 90 in./min.

8. Materials Nos. 26, 27 and 38 (Table I) may provide even more satisfactory fired specimens than Nos. 19 and 21. Baking was not complete on these materials at the time the report was made out.

Renaissance in Chelsea

by GILLIAN CRAIG

THOSE who regret the decline in production of individual pieces of pottery of artistic merit would do well to visit the studio of the Rawnsley Academy in Chelsea. Here the great name of Chelsea is being made to live again in ceramics under the inspiration of a guild of artists working in association with some of the finest craftsmen in the country. Within only two years of its inception Chelsea pottery has made a name for itself throughout the world, being represented in the museums of London, New York, and Amsterdam, and eagerly sought after by collectors in many countries.

The distinction of this pottery lies not only in the artistic individuality of every piece, but in a new glazing technique which has given it a depth and range of colour unsurpassed by any other form of ceramic decoration. It is no exaggeration to say that this unique process of glaze painting at Chelsea has established a new period in the history of ceramic art.

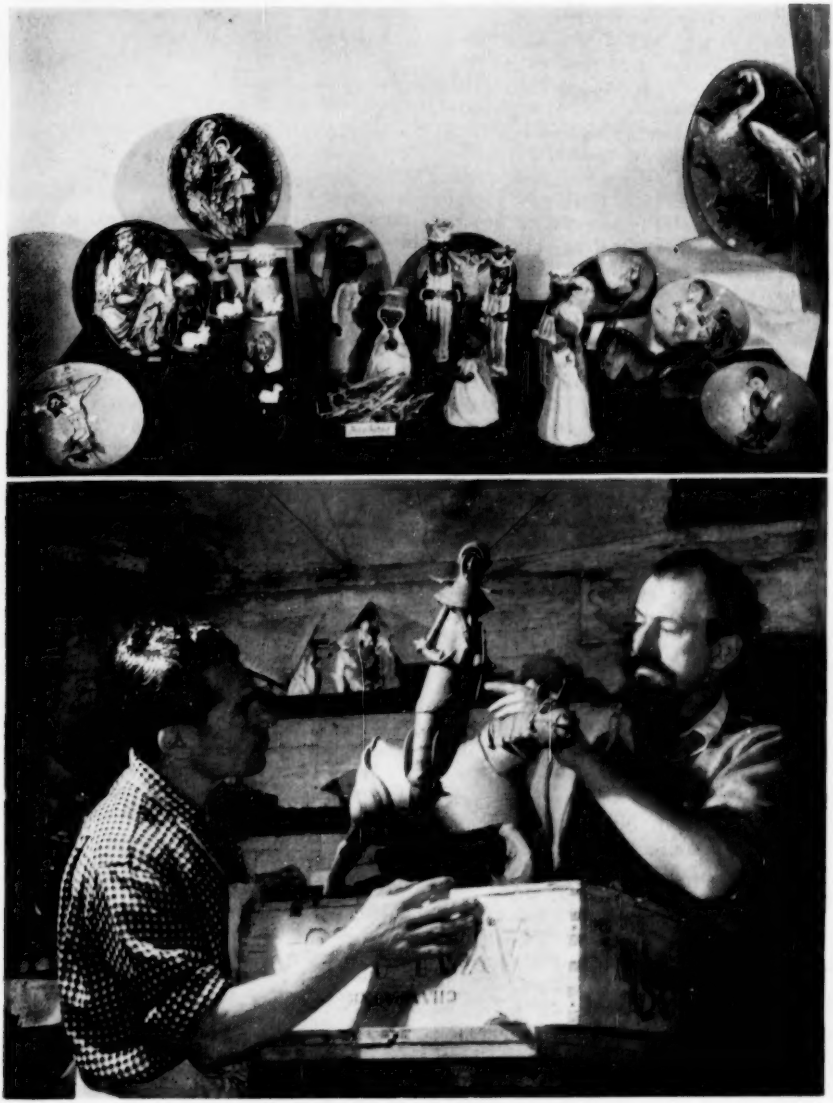
Behind this story of success there is inevitably a personality: a master with artistic energy, brilliance and ambition. As an artist David Rawnsley first became interested in ceramics as a medium which combined all three elements of texture, colour, and form. This, the most plastic of all art forms, was at the same time the most enduring; yet few artists appeared to use it as a medium for expression. Ceramics was considered the prerogative of the potter and technician and beyond the ken of the artist because of its laborious and limiting techniques. It became David Rawnsley's ambition to found a school of artists and craftsmen who would work together as a group of ceramic artists so that the artist could be freed—as far as possible—from the technicalities of his medium. With this in mind he opened the first "atelier libre" in the world in Paris, where artists and sculptors were able to explore the medium of ceramics without the necessity of first becoming skilled in the techniques of throwng and firing. It was not long before the studio became famous for its enterprise and high standard of artistic design.

When Mr. Rawnsley returned to London he found a similar need among artists who were eager to experiment in the field of ceramics. There followed a long search for premises and it was only through the patronage of Mr. William Buchanan—now a partner in the business—that the pottery finally found a home in Chelsea. The studio and kiln room were set up on the premises of the coach-building business previously conducted by Mr. Buchanan, and on 25th June, 1952, the Chelsea Pottery was officially opened.

It should be emphasised that the Chelsea artists are not studio potters. They work together as a guild and their work is sold under the business organisation of the pottery. Skilled craftsmen do the throwing, firing, and preparing of the glazes; and when problems arise in questions of glazing the finest ceramic chemists are available for consultation. The provision of these facilities has not only put ceramics within reach of artists who could not afford the cost of acquiring skill and equipment, but left them free to devote themselves entirely to creative design. In Chelsea, ceramics is being treated as an artist's medium which, while bridging the gap between painting and sculpture, has even greater potentialities than either owing to its greater plasticity. So perfect is the co-operation between artist and craftsman that they appear to work as one body in the spirit of the artist craftsman of old.

This original approach to ceramics has brought startling results. Within only eighteen months of production the new technique of glaze painting was developed which has earned this

ARTISTIC SIGNS OF A CHELSEA REVIVAL



Above: The new technique of glaze painting is shown in the work of one of the Chelsea artists—Anna Adams. Bottom: David Rawnsley (right) and John Virando with "Don Quixote," an outstanding Chelsea piece decorated by Philip Roberts

(Photograph by courtesy of the "Daily Mail.")

pottery universal praise. Mr. Arthur Lane, Keeper of the Ceramics Department at the Victoria and Albert Museum, has said that he has seen nothing like it in his experience. He considers the facility of control which the artists have obtained over the glazes to be highly commendable.

In this technique the glazes are used for their effect artistically rather than for their correct technical behaviour. Each earthenware body receives individual treatment in the hands of an artist who paints the glazes on in an intricate system of "inlay" and "overlay." This demands not only exceptional artistic ability but a high degree of technical understanding. The glazes when applied have scarcely any colour value and bear no resemblance to the product when it has been fired. The artist must, therefore, work entirely in the light of his experience of the behaviour of the glazes at a high temperature. The fact that these artists can exactly reproduce any required shade or tone of colour by mixing or inlaying different glazes proves the high degree of technical skill attained.

The colouring on most of the pieces is minutely detailed, and strange and beautiful tone and overtones have been produced by the process of mixing and merging. The colours have a range and translucent depth reminiscent of oil paintings. When it is remembered that the artist is all the time working in potential colours the artistic achievement is revealed to be outstanding.

The craftsmen who throw and model the clay are as highly accomplished in their particular field as the artists. The throwing is so finely executed that many of the pieces ring like a bell when touched. All the work is carried out by hand, either by throwing or modelling, or by a combination of both these methods. Some of the sculptured pieces are thrown in as many as six different parts. The clay comes from the Weald and the raw body is yellowish-brown in appearance. After bisque-firing, the articles are engraved by the Sgraffito method of decoration and then painted with the different coloured glazes. The pottery has its own kiln room containing four electrically-fired intermittent kilns.

The pottery's greatest charm lies in the fact that every piece is an individual of original colouring and design. The criterion of utility imposed by purchase-tax regulations does not prevent even the smallest articles being treated as individual works of art in line with the more costly collectors' pieces. It is difficult to select any one for descripton as there are already over 300 different designs. Each artist is free to experiment in his own particular mode of expression so that the variety in design is infinite and there is evidence of both classical and contemporary feeling. Plates and bowls depict characters from Greek mythology with the liveliness and realism of the original Attic vase paintings. Contemporary designs have a wide appeal because they are more concerned with recognisable subjects in nature than with abstractions.

Sculptured pieces include characters from literature such as Don Quixote and Sancho Panza, and the Owl and the Pussycat; vases, candlesticks and wine bottles are shaped in the form of lively fishes, angels, and dancing figures; a series of plates depicts "London Cries"—these are but a few examples from the wide range of products. Much of the work is exported to America, the Commonwealth countries, and the Continent. The perfect organisation of the group enables them to fulfil orders from foreign buyers of a value of £1,500 within three months.

At the moment purchase-tax prevents the artists from exploring the full potentialities of their medium but they already have plans for the future should the tax be lifted. These include 40-ft. murals, ceramic floors and furniture, and features for landscape gardens. Mr. Rawnsley believes that the plastic and permanent qualities of the medium give it endless possibilities.

The Guild is always looking for new talent, and to foster this a club is run in conjunction with the Guild which gives every member the opportunity of using the studio and its facilities for experimental purposes. The enthusiasm shown by collectors for this pottery has resulted in the formation of a collectors' society—the Chelsea Pottery Collectors' Association—which

(*Continued on page* 329)

Swedish Domestic Pottery

A Visit to Gefle Porslinsfabrik

UNLIKE its parent concern at Upsala, the Upsala-Ekeby Combine (Ceramics Oct., 1953), the plant at Gävle is given over entirely to the manufacture of moulded earthenware, producing table ware, oven ware and decorative items for the home.

The manufacture of clay products began at Gävle in 1860, when a small plant was started for the making of tiles for "kakelugnar" or tiled stoves, a means of domestic heating still in use in older houses in Sweden, but now superseded by central heating. This production ceased about 1900.

In 1910 an earthenware factory was started on the same site and continued in operation until 1923, when it came under new management. In 1936, the existing plant was purchased by the Upsala-Ekeby Combine and extended considerably in the ensuing years.

Three of the six beehive kilns first erected in 1898, and in use until 1951, still stand among the huddle of red brick buildings of those early days which screen the modern plant completed in 1951, and which is the most modern in Scandinavia. A vast, well-lighted floor space 315 ft. by 180 ft., housing the Brown Boveri double-lane continuous electric kiln for biscuit and glost firing which runs the length of it, and another, shorter, single-lane kiln.

Narrow gauge rails traverse the floor, providing easy access to the ovens, while the making shops are carefully located to ensure a continuous flow. The older building houses the slip pumphouse, decorating shops, packing rooms, ateliers, offices, showroom, etc.

The china clay originates in England, Fowey, Plymouth and Poole, and is fed by mill to the filter presses. Filter cloths of nylon have here done duty for several years, and are found to be superior in every way. A "Blencut" blending machine is also installed in the filter press shop.

Although the traditional skill and mystery of the craft of throwing has given place to machine operations, there is yet a fascination in seeing a slice of wet pug emerge from the press having shape and dimension.

The pug, in cylindrical loaves some 12 in by 7 in., is stacked end up on a carousel, which revolves to the touch, and is sliced automatically by a wire as required and thrown by the operative into the mould. The automatic arm, actuated on cantilever principles, dips into the spinning mould, the clay is momentarily pressed, the surplus ejected, and the charged mould set on to the drying wheel to the left of the press. There are both fully and semi-automatic presses, evolved from a series of patents developed by the company's engineers. Both male and female labour is employed on them.

Cups, saucers, plates; hollows and flats of many kinds, are pressed in this shop. Plates in preliminary form flowed in a steady output using this sequence, working from right to left towards the aisles, where they are placed on mangle-dryers for removal and drying. Time 2 hr. 10 min. In use also are twelve Boulton-dryers. When dry the pieces are knifed

and cleaned up by hand, using female labour. Three thousand items a day was mentioned as the norm.

Medium sized oven ware was being turned out at the neighbouring Boulton Presses, a two-man operation. The piece is cut as before and thrown onto an automatic spreader. The second operative removes it and lays it over the mould, which is then transferred to an eccentrically mounted press. The making of large oval dishes calls for some application. The second operative lifts the mass above his head, and with a quick downward movement flips it neatly and accurately onto the large mould, shapes the edges deftly and transfers it to the eccentric press. A high degree of skill appears necessary to avoid undue wastage and reforming. The use of gypsum moulds has developed to a stage where the manufacture is wholly automatic, involving up to thirty combinations on occasion.

Vases of an involved pattern; jugs complete with handles, curled ivyleaf savoury dishes; there would seem to be no limit to this form of mass production, except for the more fragile bodies such as tea-cups, where the handles are pressed separately by machine, scraped and attached by hand.

The biscuit firing is at 1,200° C. and glost at 1,100° C. Decorating and lining follow the usual procedure. Borders and gold lining are carried out by hand, using a small automatic turntable. An ingenious foot-operated machine deposits coloured spots on saucers to a given pattern in a clean, smudge-free operation. Glazing by spraygun is also carried out in preference to the more usual dipping, although this results in extra handling of each piece.

A new method of transferring, by Mulder and Zoon, Amsterdam, is also used. The transfers, on film base, are soaked off their backing and the film laid straight on to the piece, right way round. This method, although speedier, is rather costly. The firing which follows is at 800° C. in this case.

The older method of machine printed transfers on a paper base for cups and saucers is still used at Gävle. Following the depositing the transfers are brushed in by hand and the piece dipped in water to free the base. Glazing and firing in glost follows.

In the mould making atelier, reached through the store, where moulds yellow with use were ranged like cheeses on shelves, we met Folke Ericsson the chief mould maker. Under his direction skilled craftsmen with gypsum blanks before them etched and cut patiently at the master patterns. Here is the fount of the whole production for domestic ware and intricate ornaments, from which eventually flows a stream of products destined for towns the length of Sweden and for Britain too.

Shapes inspired by the arts of ancient Greece and primitive Africa: flutings and scrolls and criss-cross designs emerging on the smooth white surface. Here raised, there depressed, flowing in curves to scallopings and rounded edges: even knobs and ventilation holes too. A half-etched vase pressed into gypsum and

The modern making shop at Gefle Porslinsfabrik. Claimed to be the most modern in Europe

Hand transfers

reversed to form its fellow, so completing a mould, a short cut old as the craft itself. In the adjacent atelier, with its trailing wall plants, are sample works of artists past and present; animals, figures, painted dishes, decorated vases, gay oven ware.

The trend of design, however, in Sweden as elsewhere, would seem in general to have begun to over-reach itself, and in the search for originality in a highly competitive field, to border at times on the grotesque. Lillemor Mannerheim, one of their artists from Finland, would seem to have grasped the truth of simplicity and avoided the pitfalls of embellishment.

The showroom at Gefle Porslinsfabrik contains much to interest the visitor. Lovely shapes in Celadon Green; bright table ware in simple colours. Attractive fire-proof ware decorated in pale blue, dark blue and tulip red, much appreciated in England. A unique and practical double teapot in several clear shades, designed by Arthur Percy, combines a hot-water pot with a teapot, conserving the temperature of both. Rifle club and sailing trophies such as plates and mugs, and novelties marking events in the history of the many Associations which weave the pattern of social life in Sweden.

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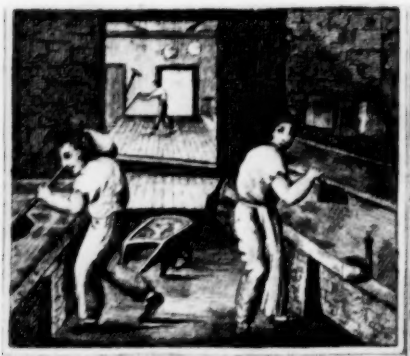
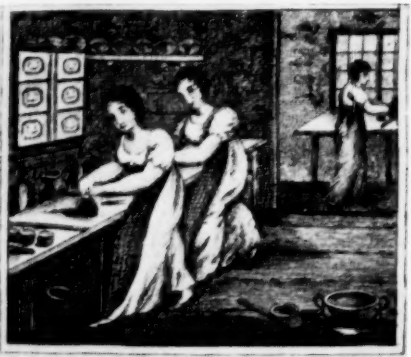
THE POTTERIES IN THE 18th CENTURY



Boiling the Slip to evaporate the water, leaving a clay about the consistence of dough.



Grinding and preparing the various colours for the Enameller or Painter.

Beating the clay to make it solid, smooth and pliable fit for the Potter.

The Turner turning in a lathe and regulating the clay ware which the "thrower" has formed.

Blending or mixing the materials with water, forming a Compound called Slip.

Placing the "dipped" ware ready for its being fired or baked in the "Glazing" Oven.

Our reproductions of old engravings come from a small and rare pamphlet on the Staffordshire potteries found in the library of the New York Metropolitan Museum of Art

—THE AMERICAN MARKET

IN the library of the famous New York Metropolitan Museum of Art there is rich material that relates to the industrial history of Staffordshire in England, particularly that of the early Staffordshire pottery trade and its effect on the American market.

At the time of the American Revolution, Staffordshire and its potteries had a huge overseas market. Josiah Wedgwood, the famous English potter published at Hanley in the year 1783 a pamphlet entitled "An address to the workmen in the pottery on the subject of entering into the service of foreign manufacturers."

In that year there was starvation in Staffordshire, and also food riots which were difficult to subdue. A great number of Staffordshire craftsmen were contemplating emigrating to the "New World" where a pottery industry was being started. This was, of course, a threat to the English pottery manufacturing trade. In his pamphlet, Josiah Wedgwood explained that it would be criminal for the workers to leave the country which has given them work and living, and that if they did manage to arrive in the American Colonies they would not find things so rosy there as they had been led to believe.

Soon after the publication of the pamphlet, the American War of Independence ended and trade with the former colonies was resumed so that prosperity returned to Staffordshire; thus Josiah Wedgwood and the whole English pottery industry was saved. Yet this prosperity, after the peace, did not last long. The dumping by Staffordshire potters of their goods in the new States, to the ruin of the infant American trade, aroused hatred against British goods. Americans refused to buy English pottery and used Canton china instead.

To counter-balance this ill-feeling, Staffordshire started to manufacture ware with the reproductions of buildings and scenes in the United States, using for this purpose a new transfer printing process. Events of American history, as well as American landscapes and famous buildings were represented on these wares. Many of these strange pottery products can still be seen in the Galleries of the New York Metropolitan Museum of Art.

This new kind of printed wares soon became very popular in America to the g r e a t commercial advantage of the Staffordshire potters. In the year 1829, Simeon Shaw published his famous "History of the Staffordshire potteries" (today a rare bibliographical desideratum). In this book, he revealed all the details of the Staffordshire potteries and their connections with America.

CERAMIC BOOK OF THE MONTH

A WORK entitled "Two Centuries of Ceramic Art" by Hugh Owen, privately printed in two volumes in 1873, was chosen for special exhibit as "Book of the Month" at Bristol Municipal Library during August.

It is concerned principally with Richard Champion and his manufacture of porcelain in Bristol in partnership with William Cookworthy, discoverer of English china clay and first maker of English porcelain. Large capital was required, which was contributed by Bristol Quakers—among others by Joseph Fry, founder of the cocoa firm. Premises were taken on the site of the old castle moat, and there Champion succeeded in producing goods which rivalled oriental porcelain, including exquisite china tea services specimens of which are now eagerly sought by connoisseurs. In 1775 Champion petitioned Parliament for an extension of his patent "as he had improved the process to an almost perfect state of excellence" and required a further term of years to recompense himself for the heavy outlay. Wedgwood opposed the application, the book relates, secured support from Staffordshire potters, and distributed a memorial to members of Parliament stating his objections. Champion in his reply wrote:

"Mr. Champion finds, however, with some surprise that Mr. Wedgwood, who has never hitherto undertaken any similar manufacture, conceives himself likely to be injured by the indulgence which Mr. Champion has solicited."

Champion was successful in the Commons, but when the bill went to the Lords, Earl Gower, who conducted the opposition for the Staffordshire potters, procured the insertion of a clause which practically nullified the advantages granted by the other House. The costs attendant on the Parliamentary bill and the collapse of his merchant trade with the American colonies preceding the War of Independence so crippled Champion's finances that he sold his patents to a Staffordshire company. After holding a Government appointment for a brief period he emigrated with his family to South Carolina, where he died in 1791.

Quickfit Catalogue in Exhibition.—A catalogue produced by Quickfit & Quartz Ltd., the well-known scientific glassware manufacturers of Stone, Staffs, has been adjudged worthy of inclusion in the exhibition of the hundred best catalogues of 1953-54 organised by the British Federation of Master Printers and the Council of Industrial Design.

Glass in South Africa

SIMULTANEOUS announcements released by Consolidated Glass Works Ltd., and Union Glass Ltd., give details of proposals to merge. Consolidated Glass Works have made an offer to acquire the whole of the £500,000 issued share capital of Union Glass and to offer in exchange four 5s. Consolidated Glass for every £1 Union Glass share ex dividend of 7½ per cent. payable for the past year. The offer was subject to acceptance by shareholders on or before 31st August, 1954. Consolidated Glass is to increase its authorised capital to £1,500,000 divided into 6,000,000 5s. shares. At a meeting which was held on 16th August, the directors have sought shareholders' approval to this capital increase and at the same time sought authority to allot and issue some 2,000,000 newly-created shares of 5s. each in satisfaction of the offer to Union Glass. The offer to shareholders of Union Glass Ltd., is conditional upon its acceptance by not less than 90 per cent. in value of the holders of shares in Union Glass. The announcements also state that the South African Breweries Ltd., owning 78 per cent. of the shareholding in Union Glass, intends to accept the Consolidated offer. The advantages of the proposed merger are referred to in the circulars. Amalgamation would result in substantial economies in the operation of both undertakings.

Production would be rationalised and place the bottle-manufacturing industry in a stronger position to meet competition from overseas glass factories. A further advantage is that the new glass container factory is to be established in the Cape Province. Both companies are substantial suppliers of glass containers to the wine, spirit, brewing and canning industries of the Cape and both regard the establishment of a Cape plant as a matter of urgent importance. The economy of one plant in the Cape instead of two operated separately by each company is apparent. A table included in the offer gives details of the profits earned and dividends paid by Consolidated for each of the past five years. In that period Consolidated has been able to repay in cash out of its own resources loans totalling £608,000, reducing its present outstanding loans to £23,100. In the four years since 30th June, 1950, Consolidated Glass has earned about £600,000 in profits before taxation, and in the same period has set aside about £137,000 as working costs reserve and provision for rebuilding furnaces. The balance sheet for Consolidated Glass at 30th June, 1954, now in course of preparation, shows that the assets exceed liabilities by about £1,167,000. For the year ended 30th June, 1954, Consolidated Glass paid a dividend of ten per cent., compared with 6¼ per cent. for the previous year. Union Glass dividends have been at the rate of 7½ per cent. for the past five years.

Consolidated Glass operates two factories—one at Wadeville, Germiston, and the other at Pretoria. The Wadeville factory, which came into production in the year 1948, is considered one of the most up-to-date in the world and manufactures glass containers of all types. The Pretoria plant, which is older, was recently modernised, and according to the last chairman's statement, "has enabled the company to produce a larger variety of glassware, particularly for domestic purposes." The Union Glass factory, recently re-equipped with modern bottle-making machinery, is located at Talana, Natal, where it has operated profitably for the last thirty-five years. The Talana factory is strategically situated to supply the coastal trade of Natal, which market had increased considerably in the past few years.

Some time ago the Department of Mines reported that it is certain the Union has vast resources of sand suitable for the manufacture of all but the very finest grades of glassware. At present, the operating glass factories have been drawing supplies from Pretoria, and the Cape Peninsula amongst other places. A deposit of considerable extent near Pienaarspoort siding, in the Pretoria district, has yielded a pale yellowish-white sand of uniform characters, and the best quality of which, when washed, gave 99·46 per cent. SiO_2, and 0·08 per cent. Fe_2O_3 on analysis. The sand is composed almost entirely of quartz grains which range in character from coarse fairly well rounded to very fine annular. Most grains are coated with a thin film of clay which is removable by washing. Mechanical analysis showed that 88 per cent. of the material fell within the sand grade but that it was poorly graded, containing a large proportion of super-fine sand.

Very large quantities of white sand occur in various parts of the Cape Peninsula, as well as in the beds of many rivers along the Cape and Natal coasts. Much

of the glass sands at present used comes from the Cape Peninsula where, at Glencairn, and on the Cape Flats near Muizenberg, unlimited quantities occur.

Union Glass Works have used the sand from Talana Hill, Dundee, Natal, where sand is derived from a thick bed of sandstone which crops out on the side of the hill. The sand contains a good deal of fine coal and small concretions of iron oxide. Mechanical analysis shows 86·4 per cent. of sand grade. The particles are principally subangular and angular grains of quartz coated with films of ferruginous matter. Chemical analysis showed 95·4 per cent SiO_2 and 1·2 per cent. Fe_2O_3. Sand for bottle glass is obtained from Sandspruit, Dundee. After cleaning, it showed a composition of 93·61 per cent. SiO_2, 1·42 per cent. Fe_2O_3, and 2·20 per cent. Al_2O_3. This river sand is in the form of low terraces and banks and is brownish-yellow in colour and mixed with pebbles.

The British Ceramic Society

WE give below abstracts of the three papers appearing in the Transactions of the British Ceramic Society for July, 1954.

The Thermal Conductivity of Beryllia, by R. W. Powell.—A longitudinal comparative heat-flow method has been used to determine the thermal conductivities of five samples of beryllia, three of which were hot-moulded and of high density, over the range of 50° to 400° or 600° C. The thermal conductivity of beryllia is higher than that of most refractory materials, and, at the lower temperatures, exceeds that of beryllium. The thermal conductivity of the oxide, however, decreases more rapidly with increase in temperature, so that it has lower values than the metal at high temperatures. Within the range studied, the thermal conductivity of beryllia varies approximately inversely as the absolute temperature and, at any one temperature, varies approximately linearly with the density.

Comparison is made with values reported by other workers.

Low-Temperature Glazes, by Felix Singer.—The theoretical considerations underlying the physical properties of glassy substances are reviewed, with particular reference to the development of low-temperature glazes and enamels. A number of examples of these are given and possible starting-points for further work in this field are indicated.

Phase Relationships of Iron-Oxide Containing Spinels: Part II. Relationships in the Systems Fe-Cr-O, Fe-Mg-O, Fe-Al-Cr-O, and **Fe-Al-Cr-Mg-O,** by I. G. Richards and J. White.—The reversible dissociation of ferric oxide in the systems Fe-Cr-O, Fe-Mg-O, Fe-Al-Cr-O and Fe-Al-Cr-Mg-O has been investigated as a function of temperature at constant oxygen pressure, a weighing method being used to determine oxygen loss. From the dissociation/temperature curves, and on the basis of X-ray and microscopic examination of slowly cooled and quenched samples, phase diagrams showing the equilibrium relationships between the sesquioxide and spinel phases in these systems have been constructed. It has been shown that, whereas Cr_2O_3 which forms a continuous series of solid solutions with Fe_2O_3, raises the temperature of the sesquioxide-spinel dissociation progressively, Al_2O_3 which forms two partial solid solutions, has little effect on the temperature of dissociation up to the limiting composition of the Al_2O_3-rich solid solution series. As a consequence Cr_2O_3 concentrates preferentially in the sesquioxide phase during the transformation whereas Al_2O_3, up to the latter composition limit, remains distributed evenly between the two phases. MgO because of its chemical nature can necessarily occur only in the spinel phase and causes a marked lowering of the dissociation temperature. These relationships are of general application to the complex spinels of natural chrome ore which are shown to co-exist at equilibrium with sesquioxide over a wide range of temperature in air.

The influence of temperature and composition on the rate of dissociation of ferric oxide in these systems has also been investigated, as well as changes in linear dimensions accompanying dissociation on heating and reoxidation on cooling. In all cases it was found that an expansion occurred during the transformation to spinel whereas a contraction occurred during reoxidation. It is believed that these findings have a significant bearing on the behaviour of chrome and chrome-magnesite refractories in service.

A New Long-Life Element

SILICON carbide electric heating elements have been coming more and more into use in recent years for high temperature furnaces. They have many advantages over metallic elements. They can be operated at high temperature and watt loadings. They can be brought quickly up to temperature without the need of any complicated control system. They can be used in conjunction with all the normal types of refractories. They do not require protection in special atmospheres and they are comparatively inexpensive.

Nevertheless they have hitherto suffered from other disadvantages perhaps the most important of which is that their useful life is generally short. Furthermore, this country has, up to now, been dependent on imported elements.

The Morgan Crucible Co. Ltd., of Battersea Works, London, S.W.11, with its extensive knowledge of refractories and experience in furnace and foundry practice has now succeeded in improving this type of element. Many years of research and development work have resulted in the production of a new and unique silicon carbide element which is being marketed under the name of *Crusilite*.

This is a one-piece silicon carbide tube produced by a completely new method, in which the central hot zone is in the form of a spiral of the requisite length.

It is entirely suitable for working over a wide range of element temperature from 800° C. to 1,575° C. (1,472° F. to 2,867° F.).

Its rate of increase of resistance in use is relatively slow. This shows a considerable advance on the earlier types of silicon carbide elements, a major criticism of which has been their rapid increase of resistance in use. Known as "ageing" this characteristic has necessitated elaborate electrical arrangements to provide the voltage reserve needed to maintain the required power input. Even so, frequent replacement of the elements has been necessary every time their resistance has risen beyond the capacity of the power supply to provide adequate radiated wattage. *Crusilite* "ages" more slowly. It can be operated for very much longer without replacement.

Being in one piece it is stronger, too, than the other types of silicon carbide elements. These have, in the past, always been made in three sections, the hot zone being of a different material from the cold ends. The cemented joints have been a frequent source of failure; and distortion when heated has been not uncommon. The new element does not suffer from these defects as it has no joints to fail.

Such is the strength of the material used in its manufacture that a highly efficient terminal arrangement can be used. At present available for the 10 and 14 mm. dia. elements only, this con-

Typical Crusilite elements (note special terminal caps on smaller sizes)

sists of special metal terminal caps shrunk on to the metallised ends of the elements.

Although, in some furnaces where space is restricted, it may not be possible to make use of these terminal caps—in which case the elements can be supplied with metallised ends only—it is hoped that users will take advantage of them. When designing a new furnace it is particularly advisable that provision should be made for this improved terminal arrangement to ensure trouble free operation.

Not only do the shrunk-on caps ensure a good electrical contact on to the silicon carbide but they also provide an easy means of connecting to the power supply. Two nuts are fitted to the threaded pillar which is an integral part of each cap. To connect to the supply it is only necessary to attach the flex or braid to the pillar and to screw the outer nut on to it. If the inner nut is held by a spanner during this operation the element cannot rotate and in fact, no strain is put on the element in any direction. The use of these terminal caps, therefore, also reduces the risk of elements being broken during installation.

The method of manufacture of *Crusilite* enables the elements to be made over a range of resistance, and suitable resistance values are held in stock to cover the electrical conditions most frequently met in common practice. Despatches from manufacturer's stock will be within a tolerance of ± 10 per cent. of the nominal, but the resistance of all elements supplied as a set for any particular furnace will not vary by more than ± 5 per cent. of the mean, and, in many cases, by considerably less. This narrow tolerance is of great advantage to users. It ensures even heating throughout the furnace and is particularly valuable when elements are connected in series.

The advent of *Crusilite*, the makers claim, should give furnace designers and manufacturers of high temperature electric furnaces the necessary confidence—which has hitherto been lacking—to proceed with further development work, whilst the user is now assured of a steady supply, with no delivery worries, of a reliable and economical heating element.

Dust Problem in Ceramics Plant

THE detrimental effect of dust from concrete floors in ceramics plant has for long been a problem to works engineers and managements. It is a problem which calls for particular attention where dust is a danger not only to personnel and precision equipment but also, as in the case of ceramics, to products and workmanship.

The problem has been tackled by scientists but only half tackled by ceramic plant executives—primarily because not enough has been made known of the cause of the dust or the antidotes which have been developed.

It is, therefore, of vital interest to learn that an investigation of the dust problem has reduced the major cause to the soft particles of lime and calcium carbonate in the concrete. These particles are stirred up by the workers' feet, by abrasion from the movement of containers or products, by mechanical handling equipment and by vibration of machinery.

In the past the problem has been approached by using silicate of soda which forms, in the main, only a superficial film or skin. Experience has shown that this skin wears off quickly and the old dust problem arises again. Silicate of soda combines incompletely with the concrete as a temporary remedy which must be repeated each time the floor goes "soft."

The alternative and only successful treatment must obviously be one in which the soft particles in the concrete are hardened and made insoluble, not merely superficially, but to a considerable depth within the concrete matrix.

A material which can produce this effect and give the dustless quality to old existing floors in addition to floors under formation has been the subject of intense research, experiment and development by the laboratories of Evode Ltd.

Progressive development has led to a prover which, it is claimed, at once eliminates dusting, resists corrosion and provides an effective hardening treatment for cement surfaces, concrete and granolithic floors.

This answer to the concrete dusting problem contains no silicate of soda. It is not a temporary treatment but penetrates the concrete, transforming the dust-forming, soft particles into hard, insoluble flint-like compounds. These

A new factory for the Morgan Crucible Co. Ltd. engaged in the manufacture of high grade refractories. The concrete floors are treated with Evode Prover II Crystals for hardening and dust-proofing

compounds occupy a larger volume than the soft materials from which they were formed, and a densifying action on the concrete provides distinct strength improvement in addition to abrasion resistance.

The result is a hard, strong floor which cannot be worn down by abrasion or vibration to that point where dust would again be generated, and one which will withstand much heavier wear without danger of crumbling.

Evode scientists have studied both the problem of the new and the old floor. The new floor receives a prover crystal treatment (known as Evode Prover II) whilst, with old floors which have been in use for more than a year, a prover solution (known as Evode Prover V), has been developed for brushing in.

The floor is given three applications, each twenty-four hours apart. The vast losses in disorganisation and wasted production hours implied in the three-day treatment have been a major consideration in development, and have resulted in a formula being extended to incorporate ingredients which allow, after the first treatment, the floor to be used within one hour. Between the second and third prover treatments the floor is not in any way affected by use. This means that after the floor has had two treatments, if it is not found convenient to give it the third treatment for several days, there is no adverse effect. It means that the floor is effectively out of use for only one hour plus the time used in application.

These provers lay the dust but, while they must inevitably improve the life of a floor, they are not calculated to create a true reinforcement of the concrete. Investigation in a cross-section of factories revealed the need for a dust inhibitor which would simultaneously waterproof and increase the strength of concrete flooring in the formation stages. Development has produced a powder called Mellitol, the consistent behaviour of which, as a catalyst, increases the homogeneous quality of concrete both in uniformity and density. It is concentrated to a degree whereby 1 lb. provides full treatment for each 100 lb. of cement.

These developed dust inhibitors have proved successful in practical application. They are being used in such widely differing spheres as Manchester's and Dublin's bus garages, one of John Brown's Clydeside factories, a Morgan Crucible Company's refractories plant, War Office Store buildings, British Electricity Authority plant, aircraft production plant, dye-houses, food manufacturing plant, soap factories and engineering plant where, in particular, precision tools are in use.

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American Ceramic Society

THE following summaries are of papers appearing in the August issues of the American Ceramic Society Bulletin and the Journal of the American Society.

Refractory Concrete for Refinery Vessel Linings, by J. F. Wygant and W. L. Bulkley. *Amer. Ceram. Soc. Bull.*, **33**, 233-239, (1954).

Refractory concretes are usually composed of aluminous hydraulic cement and calcined clay aggregates. Those which are intended especially for use at temperatures below 1,500° F. are useful as lining materials in refinery vessels and transfer lines, to resist erosion, abrasion, and certain types of chemical attack, and (with lightweight aggregates) to reduce metal shell temperatures. The best concretes for these refinery uses develop high strength within three days, are fairly volume stable and highly resistant to thermal shock, and maintain relatively high strengths at service temperatures. These and other properties, such as erosion and abrasion resistance, depend upon the type and particle size gradation of the aggregate, the proportions of cement and aggregate, and the installation methods. Proper installation is extremely important. Attention must be given to regulation of water content, good mechanical procedure in application (particularly in pneumatic application), prevention of segregation, and the best possible curing conditions. The concrete designer must consider limitations on section thickness, and must provide suitable reinforcement. Basic data for the design of reinforcement for concrete to be used at elevated temperature are very scanty. Design criteria for structural concrete cannot be extrapolated safely for high temperature applications. Also, application methods for refractory concretes usually differ from those used with structural concrete.

Advances in Ceramics Related to Electronic Tube Developments, by Louis Navias. *J. Amer. Ceram. Soc.*, **37**, 329-350 (1954).

In some of the older vacuum tubes operating at 1-mc. frequency or lower glass envelopes and porous ceramic refractories were used for internal supports. Some of the more modern electronic tubes operating at 10,000 mc. (3-cm. wave length) require vacuum-tight envelopes with (1) physical stability at operating temperatures (preferably a highly crystalline composition); (2) good mechanical strength; (3) surfaces which will take metallising; (4) metal or alloy components of comparable thermal expansions; and (5) low dielectric losses, even after being heated in a reducing atmosphere such as hydrogen, or in a vacuum. After providing a brief historical background, the author discusses changes in properties of a few crystals and glasses and gives many detailed composition studies of four types of bodies, including such properties as linear thermal expansion and dielectric properties at 3-cm. wave length, viz.: alumina, K 8·4, PF 0·0006; forsterite, K. 6·3 PF 0·0006; zircon-talc, K 7·5, PF 0·0026; and steatite, K 6·6, PF 0·0005. A brief account is presented of the development of sealing techniques and some details are given for three modern methods of making ceramic-metal seals by using (1) Mn-Mo, (2) MoO_3, and (3) TiH_2 as the active metallising agents.

Role of Nickel Dip in Enamelling of Sheet Steel, by D. G. Moore, J. W. Pitts, and W. N. Harrison *J. Amer Ceram. Soc.*, **37**, 363-369 (1954).

An investigation was made of the effects of (a) the firing time and (b) the weight of nickel deposited from the nickel-dip solution on the adherence developed by a cobalt-free and a cobalt-bearing ground-coat enamel on both enamelling iron and a titanium-bearing low carbon steel. At 1,550° F. the nickel improved the measured adherence index the most during the 2-minute firing. The effect of the nickel, however, decreased markedly with longer firing times. There was an optimum nickel deposit for maximum adherence, an optimum that varied from 50 to about 120 mg. per sq. ft., depending on the type of cleaning used and on the type of enamel applied. The nickel dip reduced the tendency to fish-scale. Furthermore, there was an apparent relation between fish-scaling resistance and good adherence; no specimen with an adherence index of 70 or above showed fish-scaling tendencies. Metallographic studies of the interface of coated specimens showed that nickel dipping of the steel before enamelling brought about a surface roughening during the firing operation. A relationship was noted between the degree of roughening and the measured adherence index. The roughening of the steel surface was ascribed to galvanic corrosion.

Density Phenomena in the Transformation Range of a Borosilicate Crown Glass, by Harold N. Ritland. *J. Amer. Ceram. Soc.*, **37,** 370-378 (1954).

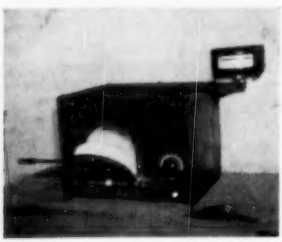
The effect of heat-treatment in the transformation range on the density of a borosilicate crown glass was studied by the method of quenched samples. An empirical equation is presented which satisfactorily represents the approach of the density to its equilibrium value at three temperatures. The density-temperature relation in the special case of cooling at a constant rate is discussed theoretically and experimentally. It is shown that if the initial temperature is sufficiently high, the density-temperature relations for different cooling rates are identical except for a displacement along the equilibrium density-temperature line by an amount proportional to the logarithm of the cooling rate. The final density reached after cooling through the entire transformation range is also shown to depend linearly on the logarithm of the rate. The implications of these results are discussed.

Processing Studies on Pure Oxides, by Louis R. McCreight. *J. Amer. Ceram. Soc.*, **37,** 378-385 (1954).

The results of some studies on the effect of (1) ball-milling time; (2) granulating by "slugging," and (3) dry pressing of pure oxide ceramic bodies are presented. When the compressive strength of specimens of single-component bodies was plotted against ball-milling time (in revolutions), minima in the curves were found between 30,000 and 50,000 revolutions. For a multicomponent body of the porcelain type and one of the oxide porcelain type, when the same data were plotted, maxima in the curves were found between 30,000 and 40,000 revolutions. Granulating by slugging provided 30 per cent. greater compressive strength, 1·5 per cent. less shrinkage, and 1 per cent. less absorption in the specimens as compared with specimens formed from ungranulated material. High-pressure forming, preferably by hydrostatic pressure, was desirable; however, there appeared to be an optimum pressure for the physical properties of each material.

Particle-Size-Distribution Analysis by a Modification of the Turbidimetric Procedure of Musgrave and Harner, by Richard S. Lamar. *J. Amer. Ceram. Soc.*, **37,** 386-390 (1954).

The turbidimetric method of determining particle-size distribution, developed by Musgrave and Harner, has been modified and adapted for use with talcs, clays, and similar non-metallic minerals and ceramic raw materials. Results obtained by this method have been found to be reproducible to within ± 2 per cent. and check with those obtained by the Andreasen pipette method within the same limits of accuracy. The turbidimetric method is useful for the direct determination of sizes from 60 to 0·25μ, equivalent spherical diameter. The entire procedure for a complete particle-side-distribution analysis usually requires less than 1 hour as compared with several days for the analysis of similar materials by the pipette method.



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FORTHCOMING B.C.S. SECTION MEETINGS

The British Ceramic Society announce that the Autumn meeting of the Building Materials Section will be held at The Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1, on Tuesday 2nd and Wednesday 3rd November, 1954. The Chairman will be Mr. A. J. C. Watts, A.M.I.E.E.

The afternoon of Tuesday, 2nd November, will be devoted to the reading and discussion of papers, and in the evening it is hoped to arrange an informal gathering.

On Wednesday morning, 3rd November, members have been invited by Mr. M. S. Whitehouse to visit the Dorking works of the Sussex & Dorking Brick Co. Ltd. In the afternoon a visit is to be paid to the Clock House hollow block works of the London Brick Co. Ltd., by kind invitation of the directors.

Further details will be given later.

The British Ceramic Society also gives notice that the Autumn meeting of the Refractory Materials Section will be held in London on Thursday, 11th and Friday 12th November, 1954.

The meeting consisting of business and technical sessions, will be held in the library of the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1, and will occupy the whole of Thursday, 11th November and the morning of Friday, 12th November. Papers will be presented on the following subjects: Casting-Pit Refractories, The Bursting Expansion of Chrome-Magnesite Bricks, Abrasion Resistance, The Sintering of Magnesite, The Catalytic Conversion of Quartz, The Refractoriness-under-Load Test.

On the evening of 11th November it is hoped to hold an informal social function.

The detailed programme will be sent out five weeks before the meeting to all British members of the Society and to those foreign members who signify to the section secretary their intention to be present.

TECHNICAL MEETINGS IN PARIS

The Third Salon de la Chimie et des Matières Plastiques, which, as already announced, will be held from 3rd to 12th December, at the Porte de Versailles, Paris, will be the meeting place for a number of international conventions—the "Technical Meetings in Paris." Specialists in many fields have already signified that they will attend. The meetings will, therefore, undoubtedly provide a most useful forum for the interchange of information.

The most recent developments in the production of basic chemical raw materials, their processes of manufacture and methods of use will be the general subject of the series of lectures and discussions. Specialists in various branches of each field will take part. Members will lunch together at each daily session.

These meetings should attract great interest in technical and industrial circles and will be divided into the following groups:

Friday 3rd December, New Vacuum Techniques; Saturday, 4th December, Perfumery and Cosmetics; Monday, 6th December, Chromotography and Ion Exchange; Tuesday, 7th December, The applications of Microscopy in chemistry; Wednesday, 8th December, Antifouling Paints; Thursday, 9th December, Electronic Techniques in the Service of Chemistry; Friday, 10th December, Control and Regulation Systems in Sugar Refineries. Corrosion; Saturday, 11th December, Recent Developments in Plastics. Corrosion.

At the Salon de la Chimie there will be a larger number of exhibitors than last year. In most sections new developments on show will be of great interest to production chemists and engineers.

Chemists, technologists, engineers and industrialists who wish to attend the Technical Meetings in Paris can obtain a detailed programme on application to the Secrétariat du Comité d'organisation, 28 rue Saint-Dominique, Paris, 7.

RENAISSANCE IN CHELSEA, by Gillian Craig

(*Continued from page* 316).

enables buyers to keep in close touch with the work that is being done.

The old name of Chelsea has been resurrected in ceramics but modern Chelsea ware stands for something different in method of approach and results. It represents an artist's ideal embodied in the medium of ceramics and materialised in the work of an organised group of ceramic artists. The development of a new technique has enabled this group to reach a standard of craftsmanship and artistry which has no equal in the ceramic field today. Many collectors and art critics believe that the Chelsea pottery is taking earthenware as fine as it has ever been taken. This artistic achievement may well mark a mid-twentieth-century revival in the art of ceramics.

NEW LIQUID LEVEL GAUGE

A new liquid level gauge has been designed by Isotope Developments Ltd. to indicate and, if necessary, control the level of liquid in industrial plant. As the equipment is mounted externally to the tank, the gauge is particularly suitable for measuring levels of liquids contained under drastic conditions of temperature or pressure and of a corrosive nature, such as those of molten glass in a furnace, slag in a blast furnace, liquids in high pressure polymerisation vessels and liquid handling in the oil industry. The manufacturers emphasise that this liquid level gauge has been designed to fill requirements where the more conventional types of gauge cannot be used.

The instrument consists of a radioactive source (usually Cobalt 60, with a working life of approximately five years), a detector unit (water cooled if ambient temperature exceeds 60° C.) and an amplifier which may be located up to 60 ft. from the detector. The source and detector are mounted on opposite sides of the vessel. When the liquid level is high, the radiation entering the detector is reduced, and when the liquid level falls, the amount of radiation in the detector increases. Over a given vertical distance, therefore, the amount of gamma radiation entering the detector is proportional to the level of the liquid.

The gauge is designed to work over a given change in liquid level. The precise accuracy achieved and the specified working limits depend on the diameter of the vessel, wall thickness and nature of wall, and the amount of surround, such as lagging, etc. In general, the gauge will accommodate an internal diameter of plant which does not exceed 10 ft., but, under certain circumstances, with reduced accuracy it may be possible to accommodate up to 20 ft. diameter.

The maximum vertical change in liquid level over which the gauge operates is at present 15 in. to 18 in. Over this change, the order of accuracy of indication or control is ± 2 per cent. (i.e., ± 0·36 in. for a vertical rise and fall of 18 in.). As an example, the gauge has already been applied in the glass industry to a glass furnace feeder, the internal diameter of which is approximately 3 ft., the surrounding insulating brick on either side of the furnace being approximately 9 in. thick. Under these conditions, the gauge indicates or controls the liquid level over a rise and fall of 0·5 in. The accuracy achieved over the centre 0·25 in. is 0·02 in., or, over the whole 0·5 in., is 0·04 in.

Ancillary equipment enables the gauge to give warning and/or control the liquid level as shown on a paper chart pen-recorder.

Again with ancillary equipment it is possible to maintain the level within the given working limits. On the glass furnace example quoted above, it is possible to control the liquid level within approximately 0·25 in., the accuracy of control being of the order of 5 per cent. of the maximum range over which the gauge is working.

Further information may be obtained from the manufacturers, Isotope Developments Ltd., Beenham Grange, Aldermaston Wharf, Near Reading, Berks.

HIGH INTENSITY IRON SEPARATOR

A high intensity tramp iron diverter unit to cater for burdens too large, or iron too numerous to be dealt with adequately by the conventional design of drum or pulley, has recently been developed by the Rapid Magnetic Machines Ltd., of Lombard Street, Birmingham 12.

Rapid 4T Tramp Iron Diverter

The high performance of this unit is due to special features of design which concentrate and direct all generated magnetic flux to the operational sector thus ensuring a deep impinging field of high intensity coupled with high surface strength at the point where separation is to be effected. A patented feature is incorporated which ensures smooth unhindered discharge of extracted iron obviating the normal difficulties encountered in achieving satisfactory release of tramp iron in powerful separators of this order.

Total enclosure of the stationary energising coils, the absence of slip rings, incorporation of dustproof ball bearings throughout, coupled with a minimum of moving parts, ensure a long life with negligible maintenance.

In application the unit may be operated as a magnetic drum, replace the head pulley of existing or new conveyors, or be embodied in a self contained separator. It is extensively used for the extraction of tramp iron in all its forms from a wide range of materials.

BRICKS FROM FLY ASH

AS a result of successful research by the Building Research Station, the British Electricity Authority is considering building brickworks at power stations.

Scientists working on the problem of finding a use for a troublesome waste material, the "fly ash" from the furnaces of power stations using pulverised fuel have discovered how to use it to make bricks of good quality. The work was sponsored by the B.E.A.

The fly ash problem

At many modern power stations coal is ground to a very fine powder before being blown into the furnace. The ash from coal burnt in this way is as fine as face powder and its disposal presents a big problem to power station engineers.

At present (1954) British power stations produce more than 2 million tons of fly ash per year and this quantity will probably be doubled in the next few years.

Although some ash may be used as a partial substitute for cement in large-scale concrete works, and some is being used in the manufacture of lightweight concrete blocks, there are few uses that offer a prospect of using the entire output of a number of large power stations. Of these few, the most promising is the manufacture of bricks of which over 7,000 million are made yearly.

Brickmaking experiments

The use of small percentages of ash (up to say 20 per cent.) in brickmaking is nothing new and many existing brickworks have tried making such additions. With some kinds of clay the addition of ash is beneficial as the clay is made less sticky and it can be dried and fired more easily. The ash also contains some unburnt carbon which helps to fire the bricks and so saves fuel.

It has been shown, however, by experiments at the B.R.S. (which is equipped for pilot-scale brickmaking) that equally satisfactory bricks can be made with 85 per cent. ash and only 15 per cent. clay. This discovery opens up the possibility of building new brickworks adjacent to power stations and at the cost of transporting relatively small quantities of clay, the troublesome waste product, fly ash, could be turned into bricks for houses.

Aggregate from fly ash

Another investigation by the B.R.S. has shown an alternative use for the ash. By simply treating it with water in a special machine it can be made into pellets. These are then heated to red heat, the heat once again being largely supplied by the unburnt carbon contained in the ash, and so hardened that they are suitable for mixing with cement to make concrete blocks somewhat like the familiar breeze block. This discovery is important because supplies of the clinker used up to now are dwindling owing to the increasing use of pulverised fuel.

Mr. W. A. Hartop

George Kent Ltd.—Mr. W. A. Hartop, works director of George Kent Ltd., left England on 9th September, for a two-month stay with the Kent subsidiary in Canada, Kent-Norlantic Ltd., Horner Avenue, Toronto. The main object of his visit is to assist the production organisation of Kent-Norlantic towards full operation and also to investigate further valuable export prospects for George Kent products. He will be visiting Kent-Norlantic Agencies in various Provinces, covering the whole of Canada to the Pacific seaboard.

British Titan Products.—A new publication entitled "Anatase Grades of Titanium Oxide" (B.T.P .Publication No. 26) has just been issued by British Titan Products Co. Ltd., of York. Anatase titanium oxide which is used in the manufacture of electro-ceramics is of considerable interest to the ceramic industry, and in this booklet, the manufacturers have assembled some useful information. One section lists the products uses recommended, the grade to be used and sets down the advantages claimed over other kinds of pigments. Copies of this publication may be obtained from the manufacturers.

New Nu-Swift for Danish Air Force.—Nu-Swift Ltd. announce the receipt by them of the first order for their Chloro-Flash extinguishers for use in aircraft of the Royal Danish Air Force. Charged with the new, highly efficient, fire-fighting chemical, chlorobromomethane, which, mixed with carbon dioxide, is held under constant pressure, Chloro-Flash extinguishers are particularly effective on extra-hazardous fires.

Save the Children Fund.—The annual meeting of the Save the Children Fund will take place on Thursday, 14th October, at 3 p.m. in the Grocers Hall, Princes Street, London, when the Right Hon. Selwyn Lloyd, M.P., Minister of State, has promised to speak. Mr. R. G. Yeats, who has been the administrator for the fund in Korea during the last twelve months will give an account of his work there. The fund's president, Countess Mountbatten of Burma, hopes to preside. Representatives of contributing firms, either employer or employee, who wish to attend are invited to apply for admission tickets to the controller, National "Penny-a-week" Appeal, Save the Children Fund, 20 Gordon Square, London, W.C.1.

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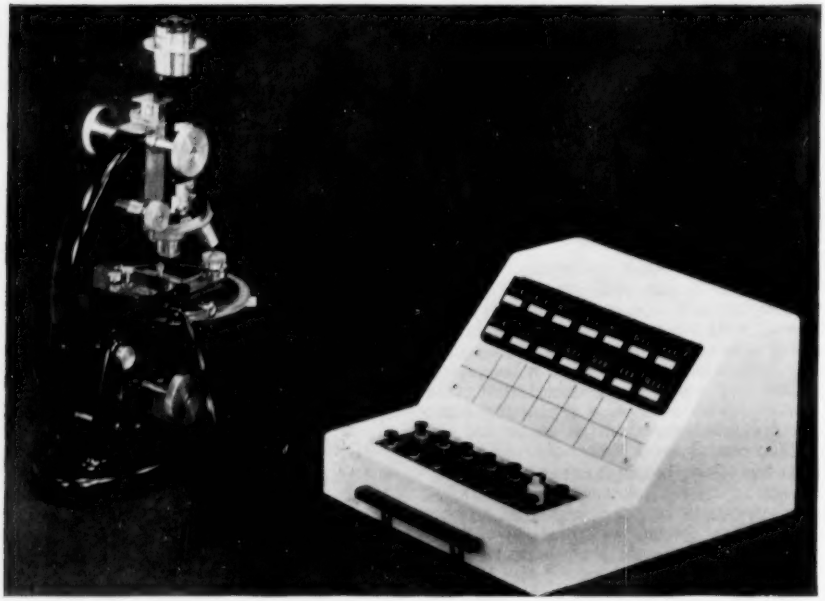

Catalogues issued by James Swift and Son Ltd., the manufacturers of scientific and optical instruments, give details of the new range of Century microscopes which commemorate a centenary of microscope making, and of the Swift *Automatic Point Counter*, which is a new analytical weapon for the microscopist in industry and research. Any mixture, transparent or opaque, whose constituents can be identified under a microscope may be analysed simply and quickly by sampling at the points of a symmetrical grid, the accuracy being dependant on the number of points sampled. The grid is spaced automatically by an electrical traverse of the microscope stage. The operator has only to identify the material at the intersection of the cross-lined graticule of the eyepiece and depress the appropriate recording button.

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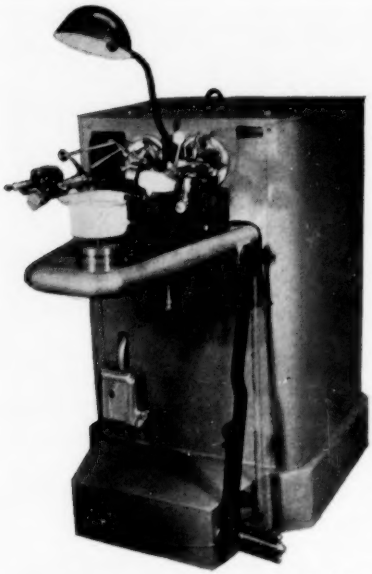

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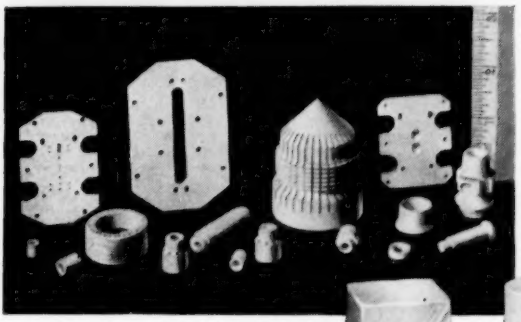

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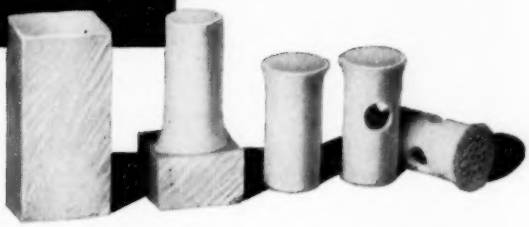

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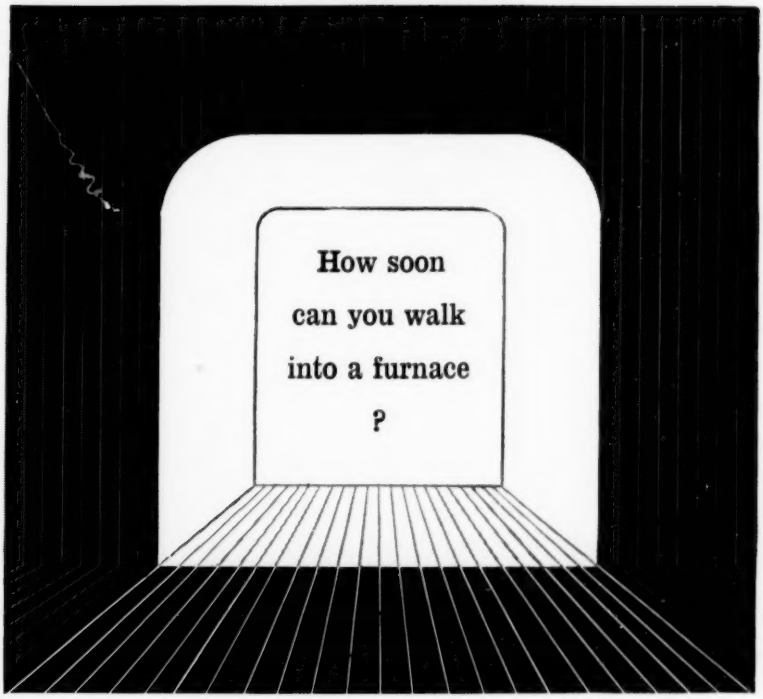

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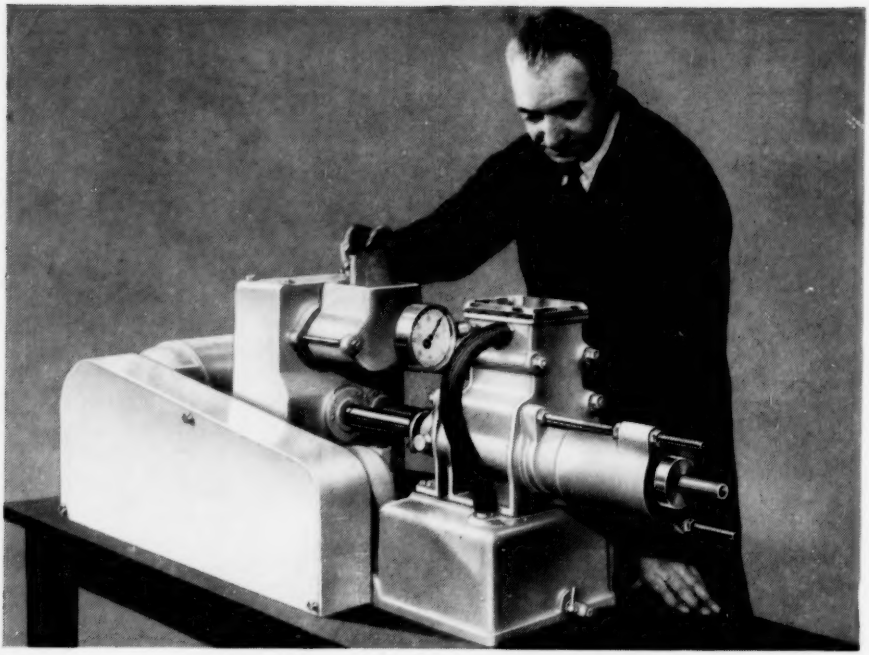

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